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EU BRITE/EURAM Program Funds Research on Embedding Sensors in Composites

BR0311100694 Kidlington ADVANCED COMPOSITES BULLETIN in English Oct 94 p 14

[Unattributed article: "In-Situ Composite Monitoring Project Receives 1.6 Million Pounds Funding"]

[FBIS Transcribed Text] Technology for embedding sensors in composites to allow in-situ monitoring and disgnostics is being developed in a 1.6-million-pound European Community BRITE-EURAM [Basic Research in Industrial Technologies for Europe/European Research on Advanced Materials] project.

The basic concept being explored is to embed an array of piezo-electric actuators and fibre-optic sensors in a composite structure. When pulsed, the actuators will provide an output which can be sensed by the optical fibres and used as a fingerprint of the structure. Changes occuring in the structure, such as cracks, result in a change in the fingerprint and can be detected using portable monitoring equipment, also being developed as part of the programme.

The research programme is aimed at providing technology for the transportation industry, particularly for use in advanced high speed trains. The consortium, which includes companies from four European countries, is led by French company Bertin et Cie. The GEC-Alsthom Engineering, Research Centre at Stafford, UK, is developing the monitoring system for the project.

Belgian SNECMA Subsidiary To Increase Combustion Chamber Life With New Ceramic

BR2510152194 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 23 Sep 94 p 36

[Article by Framboisette Jassogne: "Zircon-Based Thermal Protection"]

[FBIS Translated Text] Is it possible to increase the life expectancy of an aircraft engine's combustion chamber by improving its surface coating? Pierre Cognet, CEO of Techspace Aero, SNECMA's [National Company for Aircraft Engine Studies and Construction] Belgian subsidiary, has just taken on this challenge. He has signed a partnership agreement with the Materials Study and Research Center (CEREM) of the Atomic Energy Commission (CEA) and an SME [small and medium-sized enterprise] from the Haut-Savoie region, Baikowski Chimie, for the industrial production and use of a composite ceramic powder obtained from stabilized zircons, in particular yttrated zirconia [zircone yttriee], known as Zircyt. The quality of this powder is the direct consequence of the combination of, on the one hand, the manufacturing process, which makes it possible to obtain smooth, porous grains, and on the other hand the very high quality of the basic materials. Due to the structure of Zircyt, the powder flows more smoothly at the plasma projection phase, and consequently a high-performance thermal barrier is obtained.

CEA Advanced Technology Director Alain Bugat finds the history of this partnership exemplary. Ten years ago the engineers at CEREM, who believed that ceramics could be used throughout engines, were already working on thermal barriers for diesel engines. The aim was to increase working temperatures and obtain more efficient fuel combustion in order to increase the engine's output. In 1989, the development of ceramics took on a new magnitude as part of a BRITE/EURAM [Basic Research in Industrial Technologies in Europe/European Research on Advanced Materials] contract. That was also when CEREM and the Liege-based engine manufacturer Techspace Aero made their first contact with each other.

From that moment, with the financial support of the European Commission, the two concerns worked together with the aim of applying composite ceramic powders to aircraft engine combustion chambers, but also to rocket engine ducts. The results were encouraging. Plasma coatings using Zircyt composite ceramic powder are three times harder than the currently used coatings based on powders containing heavier, more angular grains. In addition, their resistance to corrosion is quadrupled while their resistance to thermochemical shock is increased by 50 percent. Alongside this, the treated surfaces are of better quality. These results were confirmed by the managers of Techspace Aero, who, in the light of the reciprocity agreements between Belgium and the United States, experimented with this ceramic coating on engine components used by the U.S. Air Force. In addition, tests were carried out in the combustion chamber of a Danish F-16 engine, as well as on a Belgian Army F-16 nozzle flap.

Having demonstrated the features of this type of coating, as well as its use, the two concerns still had to find a partner able to manufacture the ceramic powder on an industrial scale. The choice was Baikowski Chimie, a 75-person SME in Annecy already known to CEREM. Baikowski's current CEO, Claude Djololian, made certain to explain at the signing of the tripartite agreement that "Baikowski is the world's oldest manufacturer of very pure aluminum oxide and has reproducible expertise in the production of mineral powders." Created in 1904, it now exports 95 percent of its output and has a subsidiary in Japan and another in the United States. It supplies high-pressure sodium vapor tubes for three out of four lightbulbs sold in the world.

For Claude Djololian, working with Techspace Aero accords with "the company's strategy for developing new powders." Supplying a high-performance product with constant characteristics is, of course, an imperative aspect of the agreement with CEREM and Techspace Aero. The Belgian engine manufacturer will have exclusive use of Zircyt for all aeronautic and space applications, while Baikowski reserves the right to use it for industrial applications.

Although the development phase and implementation resources have benefited from the BRITE-EURAM contract, the manufacture of the powder should benefit, through the European Commission's VALUE research program [specific program for the dissemination and utilization of scientific and technological research results], from a little extra push in the right direction.

UK Firm Develops Prototype Composite Automotive Chassis

BR0311100794 Kidlington ADVANCED COMPOSITES BULLETIN in English Oct 94 p 9

[Unattributed article: "Protptype Chassis Developed"]

[FBIS Transcribed Text] An automotive chassis fabricated completely from composites, including a carbon fibre-based axle and suspension system, is being developed by a British company.

Matrix Advanced Composites in Taunton, UK, is developing the smart chassis, which will comprise a single unitary moulding. Company director Tim Roper says the composite floor pan will provide not only a stiff ultra-lightweight back bone, but will have the suspension moulded in as well. The suspension system comprises single oval section hollow axles, fabricated from a carbon fibre reinforced composite, that allow flexing up and down, but restrict sideways movement.

The chassis will consist of tubular carbon fibre sills with a deep elliptical profile. The tubes will be joined to carbon fibre bulkheads to stop twisting. The smart axle will pass through the tubes, with the vehicle body fitting on top of this smart floor pan.

The chassis is currently being assembled as individual components, but Roper intends to convert this to an integral moulding, probably using some form of resin transfer moulding (RTM). This will be developed as the project progresses.

The problems of introducing this sort of product into the automotive industry may not rest solely on the obvious factor of cost. Various comments from industry sources, reported in NEW SCEINTIST (London, UK), have pointed out the problems that are associated with the bulk of composite parts of this sort. The diameter of a drive shaft on a small car (sub-compact) could be about 1.6cm while a composites shaft would need to be more than 5cm in diameter making it difficult to keep the vehicle small and compact. There could be difficulties in accomodating the universal joints that allow the drive shafts to power the front wheels on front wheel drive vehicles.

Roper, however, is not discouraged and considers that the major application could come in very light vehicles, such as electric-powered cars, where weight rather than size is the dominant design factor. He sees the initial market as being for golf buggies, invalid cars, third world cars and as a standard base for kit cars. Roper is now working with an electrical vehicle consortium to develop a prototype and hopes to establish an industry standard chassis for electric vehicles.

UK: Joint Effort Develops Metal Matrix Brake Rotor

BR3110134294 Toddington NEW MATERIALS INTERNATIONAL in English Oct 94 p 1

[Unattributed article: "MMC Disc Brake Rotors and Drums Developed"]

[FBIS Transcribed Excerpt] In response to the need to reduce vehicle weight, T&N Technology and Ferodo have successfully developed a lightweight aluminium-based metal matrix composite (MMC) brake rotor to replace the heavy cast iron rotors currently used.

As yet T&N has not decided where it will make the components in volume production (if it has decided, it is not saying so).

The rotors offer a weight saving of 60 percent. At least 15kg per vehicle can be saved. And when used with a friction material specially developed by Ferodo, the rotors also offer significant performance gains. (passage omitted on warranty costs)

In fact, the development of the disc rotor was only one element of the joint R&D programme. The choice of MMC material required a completely new pad material (4042 material comprising a selection of resins and rubbers). And it is essential that the brake pad material developed by Ferodo is used in combination with the rotors, since they are an important element in the creation of a disc rotor that will effectively last the life of the vehicle.

The pad material effectively deposits a thin film of material on the surface of the disc. This helps to reduce wear, increases emissivity resulting in greater dissipation of heat by radiation, and provides a constant friction coefficient—especially important in the early life of the brake.

The combination of the two components provide a "friction couple" in which the discs offer "extremely" low wear (this can be taken as near zero); there is no generation of disc thickness variation and hence no brake judder and noise levels are reduced; and there are improved "bedding" characteristics.

The choice of MMC over cast iron leads to a reduced heat capacity. On the other hand, aluminium offers higher levels of thermal conductivity and therefore an improved potential to discharge heat out of the system. These aspects pose particular challenges for designers of brake discs, since it is important to put material where it is most needed. [passage omitted on balancing testing needs)

Dynamometer trials have proved demanding. Test schedules used for cast iron disc rotors have been used

unchanged for MMC components. Such schedules are sufficient to make a cast iron rotor glow red, yet the MMC rotors have accepted temperature rises of 200° to 250°C without a murmur (aluminium becomes molten at 600°C).

The rotors have to be machined using diamond tipped tools, and machining trials are continuing to increase the productivity of these tools—effectively increasing the number of rotors from a given set of tooling.

At this stage, all (or most) of the development has been on disc brakes for passenger cars. But MMC disc rotors for trucks will become a reality in a few years. even though energy levels are higher. These energy levels will pose additional challenges in the design of the rotor. [passage omitted on rumors of codevelopment work)

In North America, a number of vehicle builders are looking at MMCs for truck brake applications because of the large potential for weight saving. Weight savings for cars are just as relevant and the market potential is enormous.

Significantly, although they have not yet reached the same level of development,the same MMC material could be used for brake drums. T&N has produced some drum brakes in the material and is studying the results closely.

For all these components, engineers at T&N Technology at Cawston, Rugby, have selected Alcan's Duralcan F3S20S. This is a silica-based aluminium alloy with 20 percent silicon carbide in particulate form. This material is preferable to fibre-reinforced MMC, both from the viewpoint of performance and manufacturability. The present MMC particulate material can be processed through the gravity casting route.

Alcan as yet is the only major materials supplier able to offer volume supplies of this MMC material. The firm is capable of producing 50,000 tons a year. However, it is known that other material suppliers are studying the market closely. Lanxide Corporation (as already reported in these pages) has tackled the issue from the other end of the spectrum to avoid Alcan's patents. The Lanxide route infiltrates aluminium into the base silicon carbide. This tends to produce higher levels of silicon carbide, posing special problems in terms of difficulty of machining. Norsk Hydro also is thought to be studying an entry into the MMC stakes. For their part, T&N Technology and Ferodo began working in earnest together in 1993, although T&N Technology's work on MMCs goes back to the 1980s.

Aluminium MMC rotors are expected to be introduced with the 1997 model year, with widespread use predicted by the end of the decade.

France: Filament-Wound Carbon-Fiber Rods for Airbus A330/A340

BR0211155294 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 7 Oct 94 p 22

[Nicole Beauclair report: "Filament-Wound Carbon-Fiber Rods for Airbus A330/A340"]

[FBIS Translated Text] The A330/A340 will be fitted with carbon-fiber rods obtained either by the resin impregnation under a partial vacuum of a wound preform (already certified Textilver technology), or by the winding of a wire together with the contact depositing of a fiber. The second process was developed by Aerospatiale-Aquitaine, which has placed a tried and tested military technology at the service of civil aviation. Indeed, "wire winding is one of the technologies developed and validated within the framework of products intended for the French deterrence force," said Aerospatiale-Aquitaine Manager Yves-Bernard Birotteau. He also reiterated that this process is also used to make spherical tanks out of aramid (Ariane 4) and carbon (Ariane 5).

Accustomed to the constraints inherent in the military and space sectors, the company's engineers had to adjust their working methods to civilian methods, namely costs and production deadlines. Consequently, methods had to be conceived which made it possible to produce at the market price, noted Jean-Francois Lefevre, who is in charge of the composite products department, and to be organized in such a way that deliveries could be made on line and just in time. The decision to use carbon for the rods in Airbus Industrie's jumbo jets was the result of two criteria which are not of crucial importance for the other aircraft in the range, namely that the stresses caused by the carriage and the parts of the fuselage are very high and that the mass of the rods would have been prohibitive if they had been made of metal (30 percent more than a composite).

Each set comprises six different types (nine rods per type), with sizes ranging from 1,310 mm in length and 54 mm in diameter for the shortest, to 1,467 mm in length and 85 mm in diameter for the longest. The tensile load of 8 to 10 tonnes was the crucial factor for three types of rod, whereas the compression load—between 3.5 and 20 tonnes—was chosen when calculating the size of the three others. In view of these limitations and the total mass of the set of rods (87 tonnes on average for the 54 rods with individual masses from 2.4 kilos to less than 1 kilo), the HTA carbon fiber from Hexcel-Genin and the ES89 resin were used for the wire-wound version of structural rods. The specifications governing their environment were especially restrictive. The rods are located in the central tank (and are therefore bathed in kerosene) and must have a service life at least as long as that of the airplane. Following visual impact before perforation (BVID), the rod must hold for another 40,000 cycles, and 20,000 extra cycles in the event of impact after perforation (VID).

The choice of composite together with winding technology production makes it possible to guarantee long-lasting performance in view of aging in terms of temperature and in a wet environment, Jean-Francois Lefevre said. Emphasizing the fact that "the winding of fibers on a winding tube made of hardened, water-soluble sand allows the rate of fibers to be optimized"—especially since Aerospatiale has developed a programmable winding head which automatically ensures lengthwise and circular winding of the body of the rod and the creation of caps reinforced by contact depositing, a technology also used for fiber placement. To do this, the patented multi-axle head, fitted with a cutting system, deposits fibers at the tips of the rods which it then cuts to the desired length.

The industrialization aspect of rod production is of crucial importance, said Francois Tauzin, production manager, "because the machines, with 10 or so workers, allow us to produce a set of rods in seven weeks at the market price."

Each rod is inspected individually and systematically, both in terms of size and the soundness of the material by ultrasound. It is only after reception of the delivery order, just in time, that the drilling, fitting of rings, final inspection, and marking are done. Drilling is done on the basis of the specific readings taken on the airplane for which the rods are intended. The production cell produces the winding tubes, impregnates the fibers, does the winding, polymerization, painting, machining, and inspections on 130 sets of rods (7,020 rods) to be delivered by Aerospatiale-Aquitaine by the end of 1998. Some 50 percent of the contract for rods has been awarded to Aerospatiale-Aquitaine, which nevertheless has to adjust its rate of production to that of the A330/A340.

AEROSPACE

France: ONERA Applies Efficient Hypersonic Flow Measurement Method

BR0211154294 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 7 Oct 94 p 20

[Article by Christel Tardif: "Increased Hypersonic Measurement Performance"]

[FBIS Translated Text] The National Office for Aerospace Studies and Research [ONERA] has made considerable progress in the study of hypersonic flows. In recent measurements of temperatures and speeds of gas in the R5 wind tunnel at Chalais-Meudon (Mach 10 and with a low Reynolds number), the ONERA has just proved that it is possible not only to characterize a hypersonic flow (even a disturbed flow) using a single measurement method, but also of making precise measurements despite a rarefied (low pressure) atmosphere. The method used to do this is the Coherent Anti-Stokes Raman Scattering method [DRASC], a "homemade" invention using two laser sources.

This optical method, which has only recently started to be used at R5, has proved very effective for the precise measurement of temperature and density in free hypersonic flows, and for the study of complex interference between impacts created by objects immersed in a hypersonic flow. It offers significant advantages in the field of precise quantitative measurement (within 5 to 10 percent, the best precision obtained to date), offers excellent space resolution, and provides access to previously inaccessible parameters: molecular translation, rotation, and vibration temperatures (these are generally different in a hypersonic flow), together with the average speed of flow.

Naturally, there are other methods used to study hypersonic flow, but none provides all of the advantages offered by DRASC. Interferometry and trioscopy, which are more semi-quantitative, or even qualitative, are a long way from offering a similar degree of precision. Absorption spectroscopy by laser diode (or the analysis of the infrared absorption spectrum of nitrogen oxide molecules) provides the translational temperature and the flow speed. However, unlike DRASC, it has no space resolution; the data obtained are for the whole width of the working section and provide no local detail. The method of fluorescence generated by a beam of electrons makes it possible to measure the speed of flow and density, but it is semi-quantitative, has a restricted number of applications, and cannot be used in high enthalpy wind tunnels like the F4 at the ONERA's Fauga-Mauzac center.

In 18 months' time, DRASC will have been tested at F4 before it goes to Germany to be built into the instrumentation of the German aerospace research institute's [DLR] HEG hypersonic wind tunnel. This is a short-gust (millisecond) wind tunnel, ideal for DRASC which allows for data acquisition in just 15 to 20 nanoseconds. These tests and the development of this method were the result of French-German cooperation between ONERA and the DLR for the development of measurement resources for use in the study of hypersonic flows. The method designed in parallel by the DLR was laser fluorescence.

France: Aerospatiale Chief Urges EU Supersonics Cooperation

BR2810111994 Paris LA TRIBUNE DESFOSSES in French 26 Oct 94 p 13

[Report by Olivier Provost: "Supersonic—Aerospatiale Calls on Dassault for Reinforcements"]

[FBIS Translated Text] The successor of the only commercial supersonic aircraft in the world, the British-French Concorde, could this time be American, with the Europeans being relegated to the role of subcontractors in the project. That is the concern of Aerospatiale and its CEO Louis Gallois. He said yesterday at the second international conference on the subject: "It is urgent for us to talk about supersonics. Europe must not miss the

train." The first conference, in 1989, sparked fresh interest in supersonic cooperation between the French and British, the Concorde partners, and the Germans. It also triggered American efforts and resulted in the current budget allocation of $1.5 billion [8 billion French francs [Fr].

To meet this challenge, Louis Gallois called for the Europeans to wake up from their dreams of past achievements: "Europe cannot afford not to take an interest in a program of this size and the stakes it represents. It is up to France to take the initiative. With French encouragement, Germany and Britain must develop joint actions along the same lines as industrial groups." He said that his company was already working in association with the French company SNECMA [National Company for Research and Construction of Aircraft Engines], the National Aeronautics Research and Design Office, and equipment manufacturers. He added: "Why does Dassault not join us, too?" He thus put out a feeler to the military aircraft manufacturer, expert in supersonic military combat aircraft such as the Mirage and current Rafale. The subject could be brought up at Dassault Aviation's board meeting tomorrow.

Budget—Europe in the Caboose

There is concern, too, at the European level. Louis Gallois therefore stated: "I propose that Europe fully support the supersonic project to form a real technological locomotive in the aeronautics industry." This locomotive, both at the national level (with the exception of Germany) and in Brussels, is cruelly absent. Elie Khaski, director of the supersonic program at Aerospatiale Avions, points out that the Americans devoted $187.2 million to a supersonic program in 1994 alone. The Japanese, although with less of a proven track record in aeronautics, will spend $56 million this year through their MITI [Ministry of International Trade and Industry] Industry Superministry. The Europeans, however, invest less than $15 million, $7 million of which is the French contribution.

Aerospatiale has been a partner of British Aerospace since 1990 in the European Supersonic Research Program, and they were joined in April by Daimler Benz Aerospace. Now Aerospatiale is asking the public authorities for action. In 1996, Americans, Europeans, and Asians, all convinced that only one project can survive, will look into pooling their work in this area. It will then be the most advanced manufacturers and countries, i.e., the country that has spent the most on research, that will lead the project.

The stakes here are considerable. The potential market for a successor to Concorde is estimated at around 500 and 1,000 aircraft from 2007 to 2025. The development cost would be $15 billion excluding the engines (almost $5 billion more). Each aircraft would cost $250 million. Aircraft manufacturers could therefore expect turnover of more than Fr650 billion, on condition that a ticket cost no more than 15 to 25 percent more than a normal ticket. Flight times would be halved: Tokyo-Paris in five or six hours, instead of 11.5 today, and Paris-Los Angeles in 6.5 hours instead of 11.4 hours.

France: Ariane 5 Launch Facilities Described

BR2610141494 Noordwijk ESA Bulletin in English Aug 94 pp 15-26

[Article by J. de Dalmau and P. Perez: "The Ariane 5 Launch Facilities"]

[FBIS Transcribed Excerpt] New ground facilities dedicated to the launching of the Ariane 5 vehicle are now under construction at the Guiana Space Centre, Europe's spaceport in Kourou, French Guiana. They will be one of the most modern and functional ground infrastructures in the world and will provide the facilities for at least 100 commercial launches, with the first flight at the end of 1995. Although they have been custom-designed for the new, heavy-lift Ariane 5 vehicle, they will fulfill the requirements of the Ariane 5 development programme, namely a greater launch rate, reduced vulnerability to accidents, and reduced launch costs. [passage omitted]

Design and Operations Philosophy of the Ariane 5 Ground Facilities

The design of the Ariane 5 ground facilities began in 1987, upon ESA's approval of the Ariane 5 development programme. There were five major requirements:

—Custom-designed and built for the Ariane 5, a heavy-lift vehicle which is based on a different concept than its predecessors (one main, 155-tonne cryogenic stage, flanked by two solid propellant boosters weighing 230 tonnes each. On top of the main stage are the conventionally liquid-fuelled upper stage, the vehicle equipment bay, the payloads and fairings.)

—A capacity of eight launches a year with a one-month interval between launches.

—A low vulnerability, particularly in the event of a launcher explosion during the countdown or lift-off phase (in the case of an accident, the maximum amount of time foreseen to return the site to operational status is six months.)

—Good availability, safety, reliability and maintenance, the first two criteria having priority.

—Optimisation of the cost of launch operations.

—Local manufacture of most of the propellants, in order to avoid transporting large, hazardous items across Europe and the Atlantic Ocean.

The philosophy behind the Ariane 5 ground operations is closely linked to the design of the launch site, and is based on the following principles:

—Full mechanical integration is performed at the Launcher Integration Building, without any intermediate functional checks so that the functional checks can be carried out in parallel on all the sub-assemblies.

—Electrical checkout equipment and procedures used at ELA3 for the launcher stages are identical to those used by the manufacturing contractors in Europe, thus allowing comparisons and the optimisation of procedures.

—Operations and checkouts are highly automated to improve reproducibility and safety.

—The launcher is fully checked out at the Launcher Integration Building prior to payload integration.

—The roll-out to the launch area takes place just before the final countdown for main-stage fuelling, thus limiting the time that the launcher is exposed to the outside environment. In addition, the vehicle can remain in the launch area if the launch is delayed, provided that no work on the launcher or its payloads is needed.

The Ariane 5 dedicated grounds cover about 2100 hectares and include the following units:

—The booster area, comprising the Solid Propellant Plant, the Booster Integration Building, the test stand, and booster recovery and expertise facilities.

—The Ariane launch complex No. 3 (ELA3), which includes four main installations (the Launch Control Centre, the Launcher Integration Building, the Final Assembly Building, and the launch pad No. 3) and will be equipped with two mobile launch platforms or launch tables.

—Other systems, like fluids production and processing, remote checkouts and railtracks. Construction work on ELA3 began in mid-1988. Some of the facilities are already being used for the development and qualification of the Ariane 5 launcher elements and stages:

—Boosters are being tested at the booster test stand, where seven to eight tests are being carried out between 1993 and 1995.

—Cryogenic main stage "hot tests" are being performed using the launch pad as the test stand. This eliminates the need for a stage test stand in Europe, and at the same time allows the qualification of the ground facilities, procedures and operating teams. Development and qualification tests are scheduled in 1994 and 1995.

The first two Ariane 5 qualification flights are scheduled for late 1995 and early 1996. The operational lifetime of Ariane 5 is expected to last until at least 2015.

Fluids Manufacturing and Processing Facilities

The Ariane 5 main stage will carry about 130 tonnes of liquid oxygen, 14 times the volume of the present Ariane 4 third stage. A production plant, which was already on the ELA2 site for Ariane 4, has been upgraded to Ariane 5 requirements. It liquefies air to produce liquid oxygen (LOX) and liquid nitrogen (LN_2). It can produce 14 cubic meters of LOX and 60 cubic meters of LN_2 per day. The liquid oxygen is stored in five mobile tanks with a capacity of 140 cubic meters each and a sixth tank with a capacity of 20 cubic meters. The nitrogen production capacity will soon be doubled to cope with increasing needs at the Guiana Space Centre's different sites. On the same site, air and helium are compressed and fed into special underground networks.

The Ariane 5 will also carry 13.5 times the volume of liquid hydrogen that the present Ariane 4 carries (27 tonnes on an Ariane 5 as opposed to 2 tonnes on an Ariane 4). The traditional procurement of imported hydrogen containers was not suited to Ariane 5 needs in terms of logistics, economy and safety and it was found that the best solution was to invest in a new, on-site, highly automated liquid hydrogen production plant. The new plant, which has been operational since 1992, produces liquid hydrogen by reforming methyl alcohol. It can produce up to 33 cubic meters per day, to feed five 320 cubic meters mobile storage tanks. Before each launch, three of the tanks are transported by road to the launch area, a distance of about 2.5 km. Specially-designed trailers equipped with a hydraulic hoisting system and rolling on eight axles (a total of 64 wheels), carry the tanks. After launch, these tanks are carried back to the production plant and reconnected to recover the "boil-offs." This recovery drastically reduces fluid loss during transport and transfer.

Launch Complex No. 3 - ELA3

The basic concept used in the design of ELA2 has also been used for ELA3: separate preparation and launch areas. This concept has been adapted to the Ariane 5 vehicle, which is larger but simpler in design than Ariane 4.

Experience gained from ELA2 has been fully exploited in the design of ELA3:

—Vulnerability to accidents has been significantly reduced by simplifying the launch area: ELA2's sensitive mobile servicing gantry, which provides access to the vehicle at different levels and protects it from the weather, has been replaced by a fixed Final Assembly Building (BAF), located beyond the safety distance from the launch pad. The launch vehicle is only rolled out from the BAF to the launch area on its mobile platform for the final countdown (about eight hours before lift-off).

—The umbilical disconnection and reconnection process has been eliminated by using a simplified umbilical tower fixed on the mobile launch platform. The umbilicals follow the launcher from the beginning to the end of operations. This change was possible because the upper part of Ariane 5 is simpler than the Ariane 4's,

and most of the umbilical connections can be made directly between the launch platform and the lower part of the vehicle.

—The computerised servicing checkout systems (remote monitoring and command of ground energy supply, air conditioning, fire detection and other systems) are independent of the launch vehicle checkout (remote control of vehicle fuelling, pressurisation, on-board electrical systems and countdown procedures until lift-off).

Built near the ELA2 site, ELA3's two areas are:

—The launcher preparation area, which is composed of three operational buildings: the Launcher Integration Building (BIL), the Final Assembly Building (BAF), and the Launch Control Centre (CDL3).

—The launch area (ZL3).

The launch area is located about 1800 m to the north of the preparation area. The Launcher Integration Building is about 400 m from the Control Centre and 600 m from the Final Assembly Building. These distances are based on the results of safety studies performed during the early design phase and take into account pyrotechnics regulations.

The twin railtrack connecting the Launcher Integration and Final Assembly Buildings follows a curved path and is 1200 m long. The same track continues beyond the Final Assembly Building to the launch area, a distance of 2700 m.

Launcher Integration Building (BIL)

The Launcher Integration Building (BIL) is a steel structure that is 127 m long, 31 m wide and 58 m high. It is divided into three parts: a storage hall, a main-stage erection hall, and an integration hall.

Storage Hall. Upon their arrival from Europe after being transported by sea and road, the 30 m-long cryogenic main stage, the vehicle equipment bay and the upper stage, are stored in their shipping containers in the storage hall. The cover of the cryogenic main-stage container is removed, and the main stage is lifted out of its container and onto the erection supports. This hall is covered but not air-conditioned.

Main-stage erection hall. The main-stage erection hall is located in the rear part of the storage hall. It is fitted with a gantry for the erection of the main stage from the horizontal transport position to the vertical assembly and flight position. This hall is also covered but not air-conditioned.

Integration Hall. The integration hall is separated from the erection hall by a sealed sliding door. Another door allows the boosters to be rolled in from the Booster Integration Building, in the vertical position on their transport trolley. Integration takes place on the mobile launch platform, i.e., the launch table. This hall is air-conditioned.

A seven-tiered steel structure, built above the launch table, provides access to the different levels for assembly and checkout operations. Special holding arms keep the main stage in a precise position during integration, until the mechanical connections to the boosters are made.

A third sliding door allows the whole lower composite (the main stage plus the upper stage, the vehicle equipment bay and the boosters mated on the launch table) to be rolled out in the launch position.

Operations performed. The operations performed in the Launcher Integration Building take 13 days and include:

—Mechanical integration of the main stage, upper stage, vehicle equipment bay and solid boosters on the launch table.

—Electrical and pneumatic connection of the umbilicals.

—Leak checks and functional checkouts.

—Installation of pyrotechnic and additional equipment, dynamic flight control and overall electrical checkout, and preparation for transfer to the Final Assembly Building.

Roll-out is carried out in a no-voltage configuration, with automated monitoring of pressure inside the main stage, to preserve the integrity of the common bulkhead between the oxygen and hydrogen tanks.

Final Assembly Building (BAF)

The Final Assembly Building (BAF) is a steel structure that is 85 m long, 52 m wide and 83 m high, and is fully air-conditioned.

It is divided into four main parts:

—The payload encapsulation hall, which is air-conditioned in the Category 100,000 with respect to cleanliness.

—The integration hall which has a lower part that allows access to the lower composite, in the same way as in the BIL, and an upper part, also Category 100,000, that allows access to the vehicle equipment bay, the payloads and the fairing. For the most common type of launch, one with a double payload, the lower payload is lifted through a clean chimney and mated directly onto the vehicle equipment bay. The upper composite is then mated on top.

—Other facilities are the clean storage area; the main airlock for receiving payloads and small launcher items; and the main vertically-sliding door which is 24 m wide and 62 m high to allow the vehicle to be rolled in and out.

Operations performed. The operations performed in the Final Assembly Building take eight days and include:

—Roll-in from the Launcher Integration Building into the integration hall; mating of the upper payload onto the "Speltra," a flight structure for multiple payloads, in the encapsulation hall.

—Main-stage purging; assembly of the two fairing half-shells onto the Speltra, thus making up the upper composite; and transfer of the lower payload to the main airlock.

—Upper and lower payload checks; hoisting of the lower payload and mating on the launcher.

—Hoisting and mating of the upper composite; and preparation of the upper stage, solid boosters and main stage.

—Fitting of flight batteries on the stages and the vehicle equipment bay; payload checks; and final inspections.

—Loading of the upper stage with mono-methyl hydrazine (MMH) (automated and remotely controlled from the Control Centre) and the attitude control system with hydrazine (manually); and a dry run of the general launch countdown to check range safety interfaces and tracking and telemetry stations.

—Automated and remote loading of the upper stage with N_{24}; payload arming; and upper part inspection.

—Launcher arming; remotely controlled pressurisation of the main stage and booster high pressure vessels; and remotely controlled loading of the main-stage liquid helium sphere.

—Roll-out to the launch area.

Many of these operations form part of a typical launch countdown sequence, which is usually carried out on the pad. However, in order to reduce launcher vulnerability and keep the launch pad as simple as possible, the operations are carried out in the BAF at a safe distance from the pad.

Construction of the BAF started in mid-1993 and should be completed during the first quarter of 1995.

Launch Control Centre and Checkout Systems

The Launch control Centre (CDL3) is made up of two main areas:

—An office and computer area.

—An area housing two fully independent vehicle checkout control rooms (allowing the monitoring of two launchers simultaneously), and three payload control rooms. That area is reinforced to protect personnel and equipment during a launch.

The checkout systems are used for remote control and command of electric and fluid processes, both for the ground facilities and on the launcher itself. Four main sub-assemblies have been developed:

—the utilities checkout system

—the operational checkout systems

—the upper section checkout system

—the payload checkout systems.

Utilities checkout system. The utilities checkout system (CCS) is used to monitor and control remotely the site's power, air conditioning, fire and gas detection systems. These controls are needed on a permanent basis, and have no direct link to the launch vehicle. The fully backed-up system includes several consoles in the Control Centre connected to front-end processors located in each ELA3 building and inside the launch table, and a "supervisor" that automatically detects malfunctions and switches to the back-up system. In case of a technical alarm during non-working hours, the system uses the paging network to notify the appropriate on-call technicians.

Operational checkout systems. The operational control and checkout systems (CCO) are two independent command and control chains for the management of the launch vehicle's fluid and electrical systems until lift-off, and the corresponding ground interfaces. Each system has a dedicated control room in the Control Centre, and can be connected to either launch table, thus allowing the monitoring of two launch campaigns simultaneously (with one vehicle in the Launcher Integration Building, and the other in the Final Assembly Building or in the launch area). The system architecture includes front-end processors located inside the launch table and in the launch area terminal building, processing units located in the Control Centre, and networks and dialogue peripherals to complement the control room consoles.

Each of the two operational control systems is fully backed up, and includes an independent safety chain that allows a return to a safe configuration, independently of the hardware and software status of the functional systems. On yet another level, a fully independent manual system can override the automated systems to restore a safe environment in case of failure, in particular through cryogenic main-stage draining.

A new philosophy has been adopted for the Ariane 5 checkout systems, representing an innovation in the Ariane programmes. A whole "family" of checkout systems is being developed using the same specifications for the "stage" checkouts in Europe and in Guiana, as for the CCO in Guiana. This approach has two main objectives:

—To minimise development costs

—To ensure that controls among the different checkout systems are standardised, so that the same stage-level tests performed at the production sites in Europe can be repeated during the launch campaign in Guiana and can be compared in a coherent way.

Upper section checkout system. This system is used for the functional checkout of the upper composite wiring before and after the integration of each unit, i.e., the Speltra, fairing, and payload adaptors.

Payload checkout systems. The payload checkout systems allow permanent control and command of the spacecraft during assembly and roll-out operations. They are provided by the spacecraft manufacturers.

The main checkout system is located in the S1, a payload processing facility 20 km from ELA3. The checkout terminal equipment (COTE) is located closer to the spacecraft: in the S3 payload fuelling facilities during fuelling or apogee motor integration, and in the Final Assembly Building and inside the launch table during payload encapsulation, roll-out and countdown. The COTE is monitored through remote consoles located in S3 or in the Control Centre. During roll-out operations, the remote consoles are linked to the COTE by radio frequency links.

Launch Tables and Launch Zone

The ground facilities include two identical launch tables, allowing a minimum interval of one month between two consecutive launches. Each table is a mobile launch platform serving as a support for the vehicle from the beginning of integration until lift-off, and accommodating fluids, checkout, power supply and air-conditioning systems. Each table is a steel structure which is 25 m long and 21 m wide, and weighs about 1000 tonnes without the launcher. It travels along a twin railtrack on 16 two-axled bogies at a maximum speed of 4 km/h, and is pulled by two special tractors. The tables also incorporate the umbilical mast and all the ground-to-onboard electrical and fluid connections.

The launch area (ZL3) is of a very simple and flat design, and is used only for the final countdown. It comprises:

—A concrete launch pad foundation to anchor the launch table. The foundation has a central flame trench with a water-cooled steel deflector for the cryogenic main stage engine. This trench is flanked by two covered, curved trenches for the two solid-propellant boosters. The outlets of the trenches are flooded with water to reduce noise. Test campaigns have been carried out in Europe with small-scale models of the Ariane 5 vehicle and the launch area in order to simulate and optimise the noise reduction systems.

—A low terminal building adjoining the pad, housing the electrical, command and fluid equipment, and the ground-to-table interfaces.

—Mobile tanks for storing liquid oxygen, hydrogen and nitrogen, located about 200 m from the pad.

—A pool for burning the vented gaseous hydrogen, a water tower feeding the various deluge operations, and four lightning protection towers.

Operations at the launch area include, after roll-out and reconnection of the table:

—Remote-controlled countdown operations: six hours for purging, loading, topping up and pressurising the main stage with liquid oxygen and hydrogen; and activating and checking the on-board electrical circuits.

—Final synchronised sequence: a six-minute, fully automated, sequence of controls and commands carried out by the operational checkout system and synchronised with the overall range countdown.

Range Modernisation

In addition to the investments in the dedicated Ariane 5 facilities, the CNES [National Center for Space Studies] support systems at the Guiana Space Centre are being upgraded or replaced by systems that are more modern and reliable and which are compatible with Ariane 5. ESA is financing the majority of the project while CNES is performing the engineering, procurement and implementation.

A modernisation programme, called CSG 2000, began in 1991. It includes:

—Tracking and flight path quick-look display: upgrading of radars, and renewal of data processing systems in order to ensure a lifetime until the year 2010 or 2015, to improve flight safety performance and to reduce running costs.

—Ground communications system: renewal of the operational and business communications systems, based on a fibre optic network with central configuration management, which will include new telephones, faxes, intercoms, and data and video terminals.

—Telemetry and flight termination systems: adaptation of the processing system to the Ariane 5 telemetry format; upgrading of antennae; extension of data storage, data transmission and remote control of ground stations. For launches into Geostationary Transfer Orbit (GTO), ground stations are located in Kourou, Natal (Brazil), and Ascension Island. A fourth station will be located in either East or South Africa.

—Weather forecasting, safety and operations coordination: construction of a new mission control centre (called Jupiter 2) with more reliable, automated configuration and count-down management systems; development of new planning software and general spaceport-wide safety coordination; improvement of weather observation, statistics storage and forecast systems.

—Other new investments including photo and video systems (including infrared tracking cameras), construction of a large conference room, a new space museum, new launch observation sites, and new backup energy supply and air conditioning installations.

These projects are being implemented without hindering current Ariane 4 launch operations. Some of the projects are partially implemented and qualified, and are gradually providing support to Ariane 4 missions.

Testing and Qualification of the Ground Facilities

The use of the launch pad as a test stand eliminates investment in a special test stand in Europe but, on the other hand, scheduling of ground and flight hardware qualifications is more interdependent and has to be done more carefully. Each subsystem is tested at the supplier's premises in Europe before it is shipped to Kourou. Another test is performed at the subsystem level after installation in Kourou (called Phase 1), and is followed by a series of tests (Phases 2 to 5) in which more and more subsystems and more and more automated control and command systems are added, before the actual, global system test (such as a hot test of the cryogenic main stage on the launch pad) is performed.

In 1991, the utilities checkout system was installed and checked; it has been operational since that October. In 1992 and 1993, the first fuelling tests of a main-stage mockup (called the "battleship" version) were performed on the launch pad. They validated the ground systems and manual procedures for handling liquid oxygen, liquid hydrogen, nitrogen, and helium. Related systems were also tested: venting and burning of the Vulcain engine cooling hydrogen, fire extinguishing, water deluge and associated control and command systems.

In 1994, the first operational control and command system (CCO) is being installed and tested, to allow the first main stage hot tests ("battleship" campaign) in the same year. One maturation (M) and one qualification (Q) campaign are scheduled for late 1994 and early 1995 using flight-type main-stage reservoirs and the Vulcain engine. During these campaigns, nominal as well as some non-nominal situations such as an aborted launch are rehearsed, and the performance of the backup and the safety systems is verified.

A major mechanical validation campaign, called MDO1 was performed in September 1993 in the Launcher Integration Building, with the integration of two boosters and one main-stage mockup of the mobile launch platform. Three more major mechanical validation campaigns are scheduled before the launch campaign for the first flight (in 1995). They will involve, apart from the Launcher Integration Building, the Final Assembly Building and the launch pad.

Closing Remarks

The Ariane 5 ground facilities and range modifications will be ready for the first Ariane 5 launch at the end of 1995. Before that time, the facilities will be used for static test firings of the solid boosters and the cryogenic main stage. They will also be used for Ariane 5's two qualification flights. The total investment is expected to be roughly one billion ECUs, which includes the cost of operations and testing until the first commercial flight in 1996. The facilities are then expected to be used commercially for at least 100 launches. The aim is to retain, with Ariane 5, the 50-percent share of the commercial launch market that Arianespace currently enjoys with Ariane 4.

The ground facilities will satisfy all of their design requirements. The objective of eight launches per year with the possibility of two successive launches one month apart, will be easily achieved because two launch campaigns can be conducted simultaneously with, for instance, one launcher in the preparation phase in the Launcher Integration Building while a second one is in the Final Assembly Building and launch area. This is possible because ELA3 has two operations rooms, two launch tables and two operational checkout systems.

A low vulnerability rate has also been achieved through the very simple design of the launch area, stripped of all but the most essential equipment, and through the use of mobile storage facilities and two launch tables. Good reliability, maintenance, availability and safety have been made possible by building redundancy into the fluids process and operations command and control systems, and by setting up safety systems that are completely independent of the operational systems. The very high degree of automation in operations also makes for considerable gains in availability during countdown and safety since the risk of human error has been drastically reduced.

During the Ariane 5 development phase (until and including the second qualification flight in 1996), CNES and its European subcontractors are operating the ELA3 facilities. The industrial structure for the subsequent, commercial phase, i.e., the companies or groups of companies that will be responsible for the maintenance and operations of the various systems, is now being established. Arianespace will manage the operation. The industrial organisation must take into account the resources and synergy needed for the overlap phase between 1996 and 1999 during which the ELA2 and ELA3 complexes will operate simultaneously to ensure a smooth transfer from Ariane 4 to Ariane 5. Special production facilities, such as the booster area and the liquid hydrogen and oxygen plants, are operated under direct industrial responsibility.

The short duration of launch operations (22 working days) contributes to the objective of reducing launch costs by 10 percent compared to the cost of launching the most powerful version of Ariane 4 (the 44L version). This short launch-campaign is possible because of the design of the facilities and the way operations and the principles that apply to them are organised; automation,

checks done in parallel for all the stages and the fact that checks done in Europe can also be performed in Kourou.

With minor modifications, these facilities can also be compatible with Ariane 5 crewed and cargo missions—now under study—to future space stations.

ESA Confirms Ariane 5 Launch in Fall 1995

BR2810123694 Paris LIBERATION in French 27 Oct 94 p 7

[Report on an interview with ESA Ariane 5 Project Manager Jacques Durand by Edouard Launet: "The European Space Agency Replies to Criticisms of Ariane 5"]

[FBIS Translated Text] The European Space Agency (ESA) has just announced that the first flight of the new European launcher will take place in the fall of 1995. This is one way of responding to the prophets of doom who believed that the program worth more than 35 billion was on the brink of failure.

On 29 November 1995, the first Ariane 5 will blast off into the sky above Kourou. At least that is the objective that the ESA has just set for itself and the National Center for Space Studies (CNES), which the ESA commissioned to implement the project.

Propulsion Problems

This challenge appears rather ambitious if the criticisms raised here and there since last June are to be believed, namely that the cost of the program (launched in November 1987) has supposedly been greatly exceeded, that the development of the Ariane 5 propulsion system is raising serious problems, and that the new launcher is supposedly poorly adapted to the profile of the satellite market as anticipated up until the end of the century.

Jacques Durand, the head of the Ariane 5 programme at the ESA, refutes all these criticisms in one fell swoop: "It is no mean performance to be capable today of saying that we shall respect—give or take a few weeks—the deadlines laid down eight years ago (until now the date of the first launch had been decided as 3 October 1995—LIBERATION editor's note). In any case, it is proof of our confidence in the smooth running of the project. The launcher development costs should, in the long term, exceed the envelope earmarked for the program (ECU5.5 billion, or more than 30 billion francs) by 17 percent. However, we will remain within the 20-percent risk margin planned into this kind of project. In how many industrial programs as ambitious as Ariane 5 will we be capable of announcing one year ahead of the scheduled development that the costs will not be exceeded by more than 20 percent?"

What about the technological problems, primarily concerning the solid-fuel engines? "It is wrong to say that the powder mixtures have not been perfected," insisted Jacques Durand. "Admittedly, today we are using some components of U.S. origin, but in the long term we will not be dependent on the United States." The ESA describes the overall picture of the state of advancement of the program as "encouraging," and the series of trials under way have been described as "positive." However, at the beginning of October, Daniel Mugnier, in charge of launchers at the CNES, told the NOUVEL ECONOMISTE that "one year away from the first shot, everything is critical." The meaning of this remark was scorned, reply the CNES and ESA. "This affirmation, which I back to the hilt, merely means that everything is progressing in parallel, and that the margins for error are narrow," explained Jacques Durand. "Moreover, it proves that this program, on which 6,500 people are working in Europe today, is well-managed."

How well-suited to the market that seems to be developing up until the year 2000 is the new launcher? "The performance of Ariane 5, which will be capable of taking a useful payload of up to 6 tonnes into geostationary orbit (the orbit used by telecommunications satellites, which account for 75 percent of all launches—LIBERATION editor's note), is perfectly suited to the development of the market. All the telecommunications operators are predicting an increase in the weight of their satellites, taking them up to a weight of 3 tonnes. So Ariane 5 will be capable of launching two such satellites instead of one—the capability of Ariane 5's U.S. competitor, the Atlas 2-AS."

Tough Competition

In spite of such buoyant confidence, the challenge to be met by Ariane 5 promises to be tough. The number of satellites to be launched will drop from 24 this year to just 16 or 17 at the start of the next decade. However, the number of actors on the market for launches will continue to grow. Arianespace, the European profferer of services, will have to compete not only with U.S. and Russian actors, but also with Chinese, Japanese, and maybe Indian launch operators. Ariane 5 is pretty much like the Rolls Royce on this market, offering 98.5 percent reliability (as against the 95 percent achieved by Ariane 4). The new launcher was designed, among other things, for manned flights. However, now that the European Hermes shuttle program has been abandoned, this provision of Ariane 5's technical specifications would appear to be a heavy burden to bear in an ultra-competitive market.

Although it is more powerful and more reliable than Ariane 4, the new rocket must cost 10 percent less. This is the most ambitious challenge of all, and there is no indication that it will prove possible to achieve. Last June, Arianespace estimated that the predicted cost of manufacturing the launcher was still 23 percent above the fixed objective. In other words, yes, the pressure today on the companies involved in the project is high—particularly at Aerospatiale, the industrial architect of Ariane 5.

Preparations for ESA ENVISAT-1 Mission Outlined

BR2510162394 Noordwijk ESA BULLETIN in English Aug 94 pp 69, 71

[Unattributed article: "Envisat-1/Polar Platform"]

[FBIS Transcribed Text] Preparations for the ENVISAT Mission system Preliminary Design Review (EMS-PDR), covering all aspects of the ENVISAT-1 mission, including the Polar Platform and the ground segment, are proceeding according to plan. The review will take place in June/July 1994, prior to holding an EMS/PDR Board Meeting at the end of July.

Polar Platform

Following the request by the ESA Council to reduce the Polar Platform development costs, intense efforts have been made to identify cost savings, and several de-scopings have been introduced, whilst limiting as far as possible the additional risk taken.

The Polar Platform development activities are generally proceeding well. A number of development tests have been completed satisfactorily (Radio Frequency Mock-Up Test No. 2 at BAe [British Aerospace], and Battery Compartment Thermal Test in ESTEC [European Space Research and Technology Center]).

The structural-model Service Module has been delivered to BAe for further integration activities and preparation for a launch-vehicle separation test later in the year. The Payload Module structure manufacturing is continuing, with some delays.

Manufacture of engineering-model equipment is in progress. Some difficulties are being experienced with two major mechanisms: the DRS [Data Relay Satellite] Antenna Pointing Mechanism (APM) and the Solar-Array Drive Mechanism (SADM). Both are undergoing redesigns.

All subcontracts with the Prime Contractor have now been negotiated and effort is concentrated on finalising the overall Phase-C/D contract agreement with British Aerospace.

ENVISAT-1

Progress has been made in the consolidation of the technical baseline with all the Instrument Preliminary Design Reviews having now been completed. Specific problems have been identified concerning certain interface definitions and instrument performance under particular mission conditions. In all cases, actions have been defined to overcome the problems identified, in coordination with the Science Advisory Groups whenever appropriate.

On the management side, consolidation of the Industrial Consortium activities has progressed, albeit with some difficulties. In one case, the allocated task had to be reopened to industrial competition. This is now expected to be finalised by the end of June, with the selection of a new contractor.

Ground Segment

After several iterations with the programme participants, the ENVISAT ground-segment concept has been consolidated and is considered ready for approval.

Based on this concept, the Payload Data Segment Consolidation Phase has been kicked off with parallel contracts awarded to two consortia, one led by Matra Marconi System and the other by Thomson-CSF.

European Commercial Aircraft Engine Research Program Outlined

MI2610145794 Cologne DLR NACHRICHTEN in German Aug 94 pp 2-6

[Article by Heinz Hoheisel of the DLR [German Aerospace Research Institute] Institute of Design Aerodynamics in Braunschweig: "The DUPRIN European Research Program—Integration of New Engine Concepts for the Commercial Aircraft of Tomorrow"; first paragraph is DLR NACHRICHTEN introduction]

[FBIS Translated Excerpt] *The next generation of engines for commercial aircraft will have to meet stricter requirements in terms of lower fuel consumption and better environment-compatibility. New propulsion units are therefore being designed primarily to achieve higher overall efficiency ratings than current turbofan engines. The overall efficiency rating is a product of propulsive efficiency, which is a measure of thrust development efficiency, and thermal efficiency, which is a measure of the rate at which heat input is converted into exploitable energy.*

The greatest potential for improving the overall efficiency of commercial aircraft engines can be realized by raising the bypass ratio (BPR), in other words the ratio of the air mass flow in the outer duct to the air mass flow in the inner, hot duct. Current fanjets work with BPR's ranging from four to six. Raising the BPR thus raises the air mass flow in the outer duct, which results in a considerable reduction in fuel requirement: A 10- to 15-percent reduction can be achieved in consumption. An increased air mass flow in fanjets thus holds out considerable potential for building environment-friendlier engines.

The result of translating this principle into reality produces what are known as very high (VHP) or ultrahigh bypass (UHB) engines. A higher bypass ratio also means, however, a larger external engine diameter as compared with current turbofans. Depending on the bypass ratio employed, the engine diameter can reach up to 60 percent of body diameter. Figure 1 (not shown) provides a comparison of engine diameter to body diameter and shows a wind tunnel model with engine simulators built true to scale. The type of simulator used represents an

engine with a counterrotating fan and a bypass ratio of approximately 20. As the engines are larger in size, the problem of the interaction between airframe and engine takes on even greater importance, because the resulting aerodynamic interferences increase sharply. In order to prevent the potential advantages in terms of consumption held out by VHB and UHB engines from being too greatly offset by the increased resistance created by the overall aircraft configuration, the theoretical and experimental tools for addressing the integration problem must be available right from the preliminary stage in the process of developing new aircraft.

BRITE/EURAM Funding

In view of the importance of this problem, the Commission of the European Communities adopted the Ducted Propfan Investigations (DUPRIN) project under Area 5 (Aeronautics) of the BRITE/EURAM [Basic Research in Industrial Technology for Europe/European Research on Advanced Materials] funding program about four years ago. German Aerospace Airbus in Bremen is in overall charge of the project, in Phase I of which, from mid-1990 to mid-1993, a total of 14 partners participated. Phase II, in which Alenia, Fokker, MTU [Motor and Turbine Union Inc], and Technofan are no participating, whereas BMW-Rolls Royce, Rolls Royce, and ONERA [National Aeronautical Engineering and Research Agency] have been brought in, began in the spring of 1994.

Purpose and Goals

If the overall aircraft/engine system is to be optimized, studies are needed to achieve low-resistance engine integration. In engines with fairly high bypass ratios, the fact that the interference resistance created by the interaction between aircraft and engine accounts for a high proportion of the overall aircraft resistance makes for less than the anticipated reduction in fuel consumption with an inboard rather than outboard engine. The DUPRIN project therefore sets out to:

—establish the installation resistance for engines with bypass ratios up to about 20 as compared with conventional turbofans;

—create and test the hardware required for this purpose in the form of wind tunnel models and engine simulators for experimental studies;

—set up an experimental data base to validate numerical computing procedures, and

—further develop for this purpose and apply numerical interference process analysis procedures.

Phase I of the DUPRIN program thus focused primarily on creating the hardware, testing the experimental facilities in the wind tunnel, and establishing the installation resistances for a UHB engine configuration as compared with a conventional turbofan. Phase II will study the lift behavior, i.e., the takeoff and landing properties, of a UHB engine as compared with a conventional turbofan. This article will set out a number of major results by way of examples.

Test Facilities

At the beginning of the program, the DLR Alvast wind tunnel model was available in half-model form for the experimental trials, which were performed in the German-Dutch Wind Tunnel (DNW). This model was expanded into a complete 3.43 meter-wide model, an Airbus-like configuration in terms of body and basic wing projection, during Phase I of DUPRIN. This model is in 1:10 scale to the Airbus 320. Phase I used a flapless wing configuration so as to study a cruising configuration. The model will be fitted with two new wings with flaps in Phase II so that takeoff and landing procedures can be studied. The resistance behavior of the overall aircraft configuration is of extreme importance to the problem of integrating new engines with higher bypass ratios and requires experimental studies, as numerical procedures are not yet capable of providing the requisite information. Resistance behavior with engine mounted is determined experimentally with special simulators. The conventional turbofan was simulated in the DUPRIN program with two turbo-powered simulators built by German Airbus. A turbine driven by compressed air drives a single-stage fan. UHB engine simulation was carried out with a completely new type of simulator, a counterrotating fan that goes by the name of CRUF, which stands for counter-rotating ultrahigh-bypass fan. This simulator is designed to simulate a bypass ratio of approximately 20 and consists of a counterrotating fan fitted with eight blades and featuring a special reverse gear to make the fan counterrotate. A four-stage turbine generates a power output of 162 kW, which is transmitted to the counterrotating fan via the gearbox. The simulator was designed jointly by the DLR and the American company Dynamic Engineering Inc. from Newport News. The fan blades for the CRUF were designed by MTU and produced in fiber-composite technology by the NLR [Netherlands Air and Space Laboratory].

The DLR-Alvast wind tunnel model, the CRUF simulator prototype, and a turbofan simulator formed the basis on which the DUPRIN program was launched. The French firm, Technofan, then built a second CRUF simulator to DLR specifications during the program. All the components of the available hardware, comprising the Alvast model with turbofan simulators, and of the CRUF simulators have been successfully used in two test sections of the DNW's 6 x 6 m closed working section, where torque measurements have been performed to establish the lift and resistance behavior of the overall configuration. Pressure measurements have also been carried out on the wing, body, and engine pod at a total of 800 points so as to identify the local aerodymanic processes that occur on the surfaces of the parts concerned. Figure 5 [not shown] provides a view of the whole measuring system that had to be accommodated

in the nose of the Alvast model. This measuring system also comprises the parameters needed to operate the simulators (rpm, pressures, and temperatures of the fan and turbine flows to establish thrust, bearing temperatures, vibrations, and oil and coolant requirements). There is a new internal balance with what are known as air bridges [Luftbruecke]—used here for the first time—in the central part of the model to prevent any residual forces from the model engine's air supply system from being transferred to the balance. This first-ever successful use of UHB simulators with a counterrotating fan installed on a wind tunnel model provided the initial findings regarding the UHB engine integration problem.

Findings

With current turbofan engines, the additional resistance generated by engine installation accounts for about 6 to 8 percent of overall resistance. The DUPRIN project sets out to establish what changes in resistance the new engines with higher bypass ratios may be expected to entail. [Passage omitted] The UHB concept presents a considerable increase in resistance in the crucial lift correction value range as compared with the turbofan. The main reason for this increase in resistance lies in the impact of the jet in the UHB concept. Even when the engine is generating no thrust (windmilling), the UHB engine's resistance is higher than that of the turbofan owing to the larger surface that the UHB presents to the flow. The laminar attitute of the frictional layer presents potential for reducing this portion. The thrust-dependent portion, which is more than double that of a conventional turbofan in the UHB concept, is more difficult to reduce.

The reason for this strong impact exerted by the jet lies in the fact that, owing to its larger fan diameter, the jet in the UHB concept comes closer to the underside of the wing, thus affecting the wing flow much more strongly. Compared with the turbofan, therefore, greater negative pressures arise on the underside of the wing in the UHB concept, as is shown by a comparison of the pressure distributions measured on the underside of the wing for an inboard and an outboard section.

This makes for a reduction in local lift in this area in the UHB concept as compared with the turbofan. It is also of fundamental importance that the fluctuations in wing pressure distribution resulting from the different engine concepts can be extremely well described by numerical methods based on Eulerian equations. Euler's findings, which do not comprise the influence of friction, are themselves thus helpful in analyzing the impact of different engine concepts, as they provide insight into details of the overall field of flow. Eulerian calculations have thus shown that an axial displacement of the UHB engine toward the leading edge of the wing makes for a further considerable reduction in wing lift.

Prospects

The available hardware, in the form of the Alvast wind tunnel model and the engine simulators, forms an excellent basis for establishing evidence regarding the problem of integrating new turbofans with higher bypass ratios. The results achieved back in Phase I of the DUPRIN program already provide a great deal of information on matters relating to UHB engine concepts, particularly regarding alterations in resistance behavior. All the experiments conducted have been fed into a database to which all the partners in the program have access to check the computing procedures, as the computing procedures will be used more intensively in the current Phase II, particularly as far as the acknowledged strong impact of the jet in engines with raised bypass ratios is concerned. Work is also under way on designing a VHB simulator scheduled to be built in a subsequent phase. The premises established in the DUPRIN program and the initial results obtained to date will make a positive contribution to the development of engines with higher bypass ratios, and the DLR is playing a leading role in the performance of this work.

ESA EUROMIR 94 Materials Experiments Postponed

BR0211105094 Paris ESA PRESS RELEASE in English 28 Oct 94

[Unattributed report: "EUROMIR Status Report No 5"]

[FBIS Transcribed Excerpt] [passage omitted on record for longest space flight by European] The five materials sciences experiments planned for EUROMIR 94 will probably be conducted at a later date by Russian cosmonauts because a crucial furnace aboard the station has failed. Extensive efforts to repair the Russian-supplied furnace, which has been aboard the station for many years, were abandoned at the weekend. Spare parts needed to repair the furnace will be shipped to the station on a Progress cargo spacecraft. The results of the materials sciences experiments could then be returned to Earth next summer aboard the U.S. shuttle after it docks with Mir.

Russian space offcials propose Friday 4 November as date for the landing in Kazakhstan. [passage omitted on French astronaut's question and answer session with school children]

EUROMIR 94 is the first of two ESA manned missions with the Russians. The next, scheduled for August 1995, will be even more ambitious, lasting 135 days and including the first spacewalk by an ESA astronaut. Christer Fuglesang and Thomas Reiter are currently training for that flight.

Germany To Invest $1 Billion in 1995 Space Program

BR0211161194 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 30 Sep 94 p 31

[Unattributed report: "Germany's 1995 Space Budget"]

[FBIS Translated Text] The German Government is due to commit 1.6 billion German marks [DM] (or $1

billion) to its space program for 1995. Compared to last year, it is maintaining its budget at the same level. Two thirds (or DM1.1 billion) will go to ESA (European Space Agency), while France only contributes half of its [space program] budget.

Germany: DASA, Fokker To Launch New Regional Aircraft Project

BR0211154694 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 7 Oct 94 p 17

[Bernard Bombeau article: "DASA and Fokker Examine the 'FAX'"]

[FBIS Translated Text] During the ceremonies in Amsterdam to mark Fokker's 75th anniversary, German Aerospace [DASA] President Jurgen E. Schremp again clearly stated his vision of a "European pole for regional aviation" built around the German-Dutch company. Fokker, the Dutch aircraft manufacturer, and DASA, its German majority shareholder, are looking to develop a new generation of regional jets for the next decade in a program christened ATSA (Advanced Technology Small Airliner). Two design offices are working on the definition of the FAX project (Future Aircraft X) which will probably correspond to a new-technology aircraft for the 100 to 130-seater niche. According to group predictions, there should be space in this niche for 2,200 new aircraft by the year 2013. For the time being, neither DASA nor Fokker will risk going into the specifics of this program "whose future will depend on changes in the market."

Nevertheless, by revealing that the FAX project exists, DASA and Fokker have made a date and restated their ambition to be at the center of a broad European association of regional aircraft manufacturers. Two main policy lines are becoming clearer from the talks currently underway. DASA, which "does not claim to want to become the leader for the whole turboprop market," has still staked a place for itself and Fokker in the regional jets niche (with the Fokker 70 and Fokker 100 twinjets).

Initial negotiations with British Aerospace [BAe] (which is gunning for a share in the capital of the Netherlands company) are aimed at grouping European regional jets in a consortium similar to the Airbus structure. BAe is attracted by this solution. Its range of four-engined Avro RJ's currently covers the 80-100 seater market. For all that, DASA does not intend closing the door on other partners and in particular its traditional allies of Aerospatiale and Alenia, currently cooperating in the French-Italian ATR [Alenia-Aerospatiale consortium] joint venture. However, unless a real—and still hard to imagine—"federation" of the European regional aircraft industry can be formed, then the future could see the creation of two distinct poles separating the jet and turboprop markets.

Germany: DLR Studies Space-Borne Corrosion of Optical Glass

95WS0026C Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 21 Oct 94 p 8

[Article: "Corrosion in Space Causes Glassware to Lose Transparency"; subhead: "DLR Tests Methods to Enhance Lifetime of Optical Instruments"]

[FBIS Translated Text] Frankfurt—Under the SESAM [Surface Effects Sample Monitor] experiment during the upcoming flight of the Atlantis space shuttle, the DLR [German Aerospace Research Institute] intends to study the way in which corrosion develops on optical glassware in near-earth space. To be sure, it was earlier demonstrated already that it is especially difficult controlling the long-term stability of optical components such as front lenses and mirrors. Depending on the circumstances, the glass surfaces may keep growing rougher and rougher to the point that, for instance, at a certain level of corrosion, optical observation is no longer feasible.

According to DLR Ltd in Cologne, the SESAM instruments are components of the German Astro-Spas satellite. SESAM was first put into service a year ago. It was then possible to detect damage to the hyper-finely polished glass surface (surface roughness less than 0.05 millionths of a millimeter) from corrosion and pelting by particles.

Contrary to popular opinion, no absolute vacuum prevails in fact in near-earth space. Residual gases from the earth's atmosphere can still be encountered there, primarily oxygen in an atomic state. Account should also be taken of mini-meteorites and space waste from earlier space flight missions. As depicted by DLR, it is the atomic oxygen that is proving to be especially highly aggressive and corrosive.

During the upcoming research mission in early November the DLR scientists, in addition to reviewing their earlier results, are also eager to discover whether the risk to the instruments can be reduced through a skillful reorientation. To do this, some of the 40 material samples will be positioned in the direction of the flight and others in precisely the opposite direction on the Astro-Spas satellite.

Italy: Alenia Spazio Major R&D Projects Summarized

MI2610142394 Milan IL SOLE-24 ORE Special Insert in Italian 15 Oct 94 p 3

[Article by Giambattista Pepi: "Alenia Spazio Is Committed to Numerous Types of Satellites—When the Business Is in Orbit"]

[FBIS Translated Text] Italy has had a strong commitment in the field of ground and satellite stations for telecommunications, telesurveying, and meteorology for

many years. Alenia Spazio controls more than 75 percent of the space market and is an essential reference point for the national space industry, that is certainly in the vanguard at a world level, to carry on with European and international research and development programs.

The greatest commitment has been in the telecommunications and telesurveying sectors for a long time. In recent years, however, substantial quotas of financial and technological resources have been dedicated to the design and construction of satellites for scientific research and for orbital infrastructures.

Telecommunications

It is not superfluous to stress the strategic as well as the economic importance of telecommunications to all the modern countries. It is therefore not surprising that our country has dedicated, and is dedicating, considerable energy to their development. Historically, Italy's first commitment in this field was the satellite Sirio-1, for which Alenia Spazio itself had industrial responsibility.

Many others followed in successive years including Sirio-2 and Olympus that were dedicated to direct television broadcasting. These led finally up to the Italsat project, carried out by Alenia Spazio and coordinated by the ASI [Italian Space Agency]. Italsat is an advanced telecommunications satellite, able to operate at high frequencies (20-30 gigahertz) using digital technologies, and a series of ground stations to control it and to make connections for the management of part of the national telephone traffic.

The cooperation agreements that have been stipulated between various national and foreign industries have given further impulse to the already substantial progress made by research.

The European Space Agency, that has launched common research programs of noteworthy value in recent years, has also given it a front line role in the incentive policies for scientific and technological research in the field.

It is sufficient to recall, for example, the DRS [data relay satellite] for which Alenia Spazio is project leader. The project plans for the construction of an integrated system for telecommunications and data transmission and for locating the European orbital infrastructure. Two satellites will be put into orbit by 1997 (Artemis and DRS), and the system will become operative by 1998. The total cost of the project is about one billion dollars (about 1.6 trillion lire).

However the programs do not stop here, also because undoubtedly in the future telecommunications will rely more and more on satellites. The EMS [European mobile satellite] project is moving in this direction and plans to put Italsat-F2, on which the EMS system will be installed, into orbit by next year. The EMS is able to satisfy the communications requirements of 70,000 users. This number will rise to over half a million by the year 2000 with the intensification of trade with the eastern European countries.

Telesurveying and Meteorology

Our country has been committed to these fields since the sixties when the European Space Agency launched the observation programs using Meteosat for meteorology from a geostationary orbit. Alenia Spazio, within a pool of companies guided by the French Aerospatiale, made an important contribution to the program, building the onboard electronic subsystems to process data coming from the sensors. So far Meteosat-1 (1997), Meteosat-2 (1981), and Meteosat-P2 (1988) have been put into orbit, as well as MOP-1 and MOP-2 on behalf of Eumetsat, the company that manages the running of the operational Meteosats.

The so-called second stage of the commitment of Alenia Spazio in this field started in the eighties with the decision to concentrate on RA [altimeter radar], SAR [synthetic aperture radar], and microwave radiometry, with the scope of reinforcing the position of the company on the market. This is how the ERS-1 [European Research Satellite-1], the first European satellite for the observation of the Earth's surface, and in particular of the oceans and the polar caps, programs started. It was followed by the ERS-2, then the Italian-German program X-SAR [synthetic aperture radar], for the construction of a synthetic aperture radar in X-band, and the Helios defense observation system (carried out through the international collaboration of France, Italy and Spain).

AUTOMOTIVE, TRANSPORTATION

Germany: Prometheus Project Studies Advanced Automotive Technology

95WS0026A Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 19 Oct 94 p 8

[Article: "Prometheus Entails New Transportation Technologies"; subhead: "Daimler-Benz Eager to Explore Limits of Technological Feasibility"]

[FBIS Translated Text] Frankfurt—Eight years after inception, the Prometheus research project is now drawing to its conclusion. The Daimler-Benz Incorporated [AG] firm in Stuttgart is presenting to the public the advances realized in the course of it this week in Paris. Demonstration vehicles are being displayed in the four subject areas of automated driving, interval control, individualized routing and fleet management.

Also, reportedly, the Stuttgart auto firm is now eager, using the VITA (Vision Technology Application) vehicle, to explore the limits of what is presently technologically feasible. In this instance a genuine autopilot will be tested that is capable of braking, accelerating and steering on its own. VITA acquires all the necessary data via automated assessment of video images. For this

purpose the on-board computer scans the lane markings up to a distance of 200 meters in order to be able to follow the course of the road.

Using 360° vision, VITA will supposedly simultaneously determine whether the vehicle is on a collision course with other objects. Automatic recognition of traffic signals has already been mastered by now—in Daimler-Benz's view, a quite useful practical aid considering the plethora of traffic signs. Still, VITA is in no case supposed to be a substitute for the driver.

The cruise control has undergone further development. It is capable of not only maintaining a constant set speed but also of varying the required distance to other vehicles. Transmitters built into the headlights emit infrared pulses that are reflected off preceding vehicles and recaptured. The on-board computer uses the signal duration to compute the distance and on the basis of that regulates the speed of its own vehicle.

Daimler-Benz is arguing that a smarter cruise control currently under development at Daimler-Benz should be provided data on any possible speed limits. The firm is advocating that transponders be attached to traffic signs using microwaves to inform passing vehicles about the type of sign it is. It could be used, for example, to cause a red light diode to light up on the speedometer dial at the maximum permissible speed.

Research results include the "dual routing" that the auto firm believes could replace road maps and city maps. Data on the best possible route will then be computed in the on-board computer and displayed on a tiny monitor. Additionally, the driver may also use speech output if it would be too dangerous to glance at the monitor in heavy traffic. This system too will be able to develop its full potential only if the traffic information system is improved and updated more rapidly. The digital traffic radio channels RDS/TMC, plus broadcast beacons in congested areas, should help in that respect. The firm plans to have the first stage of a routing system in the form of the Mercedes-Benz Autopilot System [APS] available as early as the spring of 1995 for its S-class.

Thirteen auto firms are cooperating in Europe's Prometheus research alliance. By the year 2000 they are eager to develop fresh technologies entailing a total outlay of ECU360 million (688 million German marks). Two-thirds of that total will come from industry. Also taking part in Prometheus are 50 electronics and supplier industry firms plus more than 100 research institutes. By the year 2010, market volumes in Europe are projected at ECU100 billion for infrastructure, ultimate equipment and additional services that could be undertaken with computerized media in transportation.

COMPUTERS

Hungary: Computer and Automation Institute Profiled

BR0211151294 Rocquencourt ERCIM NEWS in English Oct 94 pp 2-4

[Unattributed article: "SGFI and SZTAKI Join ERCIM"]

[FBIS Transcribed Excerpt] [passage omitted on SGFI, Swiss Society for Advancement of Informatics and its Applications]. SZTAKI is the Hungarian acronym for Computer and Automation Institute. It is the second largest institute of the Hungarian Academy of Sciences. SZTAKI performs R&D in the fields of intelligent engineering systems, informatics and computer science, integrated design, control systems and information management systems. It has a staff of ca [circa] 350, of which 250 are university graduates. The institute is located in Budapest.

SZTAKI was founded in 1972. It carries out fundamental research, contract-based targeted research, as well as development of custom-designed computer applications and turn-key systems. In 1990 the Institute underwent a major restructuring process whereby three autonomous units were formed in order to clearly separate the main types of activities: the Autonomous Research Division (AKE), the Autonomous Development Division (AFE) and the Academic Infrastructure Division (ASZI).

The Institute has established a significant network of international contacts both with industrial and academic partners. [passage omitted on example of participation] The development of a new relationship between Hungary and the European Union [EU] enabled the Institute to participate in various research and technical development programmes of the EU. The professional and academic training activity has been expanded in recent years, too. [passage omitted on role of higher education]

The Research Division The Research Division is structured into eight laboratories, employing about 90 researchers and Ph.D. students altogether. The laboratories are: "Artificial Intelligence," "Computer Integrated Manufacturing," "Analogical (Dual) and Neural Computing Systems," "Geometric Modelling," "Informatics," "Mathematical Physics and Combinatorics," "Operations Research and Decision Systems," "Systems and Control." The aim of the Research Division is to carry out fundamental research that is related to the strategic directions of the Institute. Basic funding is provided by the Hungarian Academy of Sciences.

Artificial Intelligence

Cognitive aspects of artificial intelligence [AI] and expert systems are studied to get representations of human decision methods. As a major application a medical system for early diagnosis has been developed. Applications of AI-related methods and techniques in mechanical engineering, representation of design process are another key area of research.

Computer Integrated and Intelligent Manufacturing

Examination of the flexible manufacturing system and cooperative problem-solving in intelligent computer aided design (ICAD), design and evaluation of advanced manufacturing systems, application of the methods of

concurrent engineering are main areas of interest. The laboratory opened the first Manufacturing Automation Protocol (MAP) Training Centre in Central-Eastern Europe.

Analogical (Dual) and Neural Computing Systems

Neural computing systems are considered as a model of non-linear dynamic uniform processor arrays where the analogue processors are placed on a geometrical grid. The 2D grid structure of the non-linear dynamic processors is a natural framework for image processing of grey scale pictures. [passage omitted on work with UC Berkley]

Geometric Modelling

In connection with CAD/CAM [Computer-Aided Design/Comptuer-Aided Manufacturing] software development significant research effort has been directed to problems of geometric modelling: curve and surface interpolation, solid modelling, NC [numerically controlled] manufacturing based on geometric models, visualization, modelling surfaces of general topology. The last research project is supported by the DEC External Research Program. The laboratory is also active in research on intelligent manufacturing and image and pattern analysis, especially in the problem on defect detection in textures.

Informatics

Visual and object oriented systems are a major line of research that includes object oriented languages, distributed object management, visual interaction techniques and visual databases. The research area of computer graphics, human-computer interaction and visual interface have been recently integrated into the laboratory. Research in data models and database technologies includes: design theory of relational databases, distributed database systems, hypertext and multimedia systems, and software testing. On the more theoretical side the following topics are considered: multiple-valued logics, algebraic algorithms, especially factoring polynomials over finite fields, statistical methods and applications.

Mathematical Physics and Combinatorics

The prime interest of the group of mathematical physics is in the modelling of particular phenomena occurring in continuum mechanics. Researchers in graph theory and combinatorics are working on problems of on-line graph colouring algorithms, Ramsey theory, theoretical computer science and descriptional complexity.

Operation Research and Decision Systems

This laboratory has a long tradition in carrying out research on optimization on parallel computers, nonconvex programming, stochastic programming, tensor optimization and very large-scale linear programming. Operation research and decision system applications in electric power planning, long-range marginal cost analysis and tarification have been considered for more than two decades. Numerical methods in mathematical physics, especially for ordinary differential equations and statistical analysis of economic time seriesare also part of the research.

Systems and Control

A major direction of research and development has been real-time fault and change detection and isolation in noisy environment. Adaptive control methodologies using new processing methods, time delay estimation and the theory of stochastic complexity have been developed partly in cooperation with CWI and IBM Research, San Jose, California. Among the more classical directions, parametrization issues of multivariable linear systems, qualitative modelling and continuous-time systems are to be mentioned. Symbolic methods for solving ordinary and partial differential equations by using pure symbol manipulation techniques are also tackled.

The Development Division

The Development Division (AFE) is an association of autonomous departments dealing mainly with application oriented research and development. Development Departments are financially independent, self-supporting units covering their expenses largely through development contracts. The AFE Division consists of the following departments: Information Technology, Laser & Computer Techniques, Operations Research, Power Electronics, Robotics and Computer Vision, Supervisory Control Systems.

The Academic Computer Infrastructure Division

The Academic Computer Infrastructure Division (ASZI) incorporates the Computer and Networking Centre of the Hungarian Academy of Sciences as well as several research and development departments active in centralized computer services, computer networks, network applications data base management and electronic mail systems. [passage omitted on summary of activities]

DEFENSE R&D

France's Military Space Program Outlined

BR2510161794 Burnham SPACE in English Sep-Oct 94 pp 8, 10-12

[Article by Stephane Chenard: "French Satellites in Uniform"]

[FBIS Transcribed Text] France combines every reason, good and bad, for having a large military space programme: it has nuclear weapons to target, forces from Bosnia to Rwanda needing communications and intelligence, experienced contractors to keep busy, a few vexing episodes in past relations with U.S. intelligence

agencies, and money to spend. After years of envying the United States and Russia, France's military space community is finally at heaven's door, with at least one major surveillance programme rolling on.

While the French Ministry of Defence has operated the Syracuse communications payload aboard the civilian Telecom satellites since 1984, the launch early next year of France's first high-resolution surveillance satellite, Helios IA, will usher it into a higher level of spending and activity. Appropriations for French military satellites were the world's fastest-growing space budget in 1986-90, jumping in 1990 from 1,997 million French francs [Fr] ($365.7 million at July '94 exchange rates) to Fr3,010 million. They hovered around Fr3,600 million in 1992-94, amounting to 4 percent of France's total defence procurement spending in 1994. Most of this spectacular growth was fuelled by Helios.

And more is to come. The spectacular demonstration of its surveillance satellites made by the United States during the Persian Gulf war galvanised French authorities; France's somewhat bedraggled satellite industry followed suit with an overt lobbying campaign for a follow-on to the two Helios I satellites, called Osiris, an electronic intelligence (ELINT) satellite dubbed Zenon and an early warning constellation, which had all been under some consideration since the mid-1980's. Working on a new five-year defence plan, President Francois Mitterrand's last socialist government assumed in 1992 that the military space budget would double from 1994-98, to reach Fr8 billion by 2000. In October 1993, conservative defence minister Francois Leotard requested Fr4,148 billion for military space, marking a remarkable 13.8-percent increase amid an overall defence budget growing only by 1.3 percent. All this coincided with the issuance by the Western European Union (WEU) of studies on a future European treaty verification satellite, and a flurry of studies within NATO on the possible merger of Syracuse with its counterpart on Spain's Hispasat, the United Kingdom's Skynet military communications system, and the United States Defense Satellite Communications System, all due for renewal around 2005. Germany, Spain, the United Arab Emirates and South Korea have also been said to contemplate acquiring reconnaissance satellites; United States industry officials repeatedly mentioned Helios prime contractor Matra Marconi Space NV (MMS) among contenders for these projects during 1993.

French military satellites, 1984-2004

Spacecraft	Launch date	Launch mass (kg)	Mission	Development cost (millions of French francs)	Prime contractor
Syracuse 1	-	n/a	Communications	2,000	Alcatel
Syracuse 2	-	n/s	Communications	9,230	Alcatel
Helios 1A/1B	1995-96	2,500	Optical surveillance	8,000	Matra
Cerise	1995	50	ELINT demonstrator	87	Alcatel
Clementine	1995	50	ELINT demonstrator	90	Alcatel
Helios 2A/2B	2001-03	n/a	Optical/IR surveillance	10,000	Matra
Syracuse 3	2002-05	n/a	Communications	n/a	Alcatel?
Osiris	2004	2,600?	Radar surveillance	11,000	Alcatel or Matra
Zenon	n/a	500?	ELINT	4,000	Alcatel or Matra

Osiris evolved from a number of generic studies on radar versions of the SPOT [Test Satellite for Earth Observation] system, starting around 1986 with a project called Radsat. France tried for at least three years to persuade Germany to co-operate in a radar satellite project in the early 1980s, then decided to go it alone, contracting in 1988 with two teams associating Alcatel Espace with Thomson CSF and Matra with Dassault Electronique for definition studies. CNES has more recently funded studies on ostensibly civilian projects, Radar 2000 and SPOT Radar, one CNES article on Radar 2000 mentioned the objective of a resolution of up to 1.5 m in a 30-km swath, corresponding to 20 times the resolution of ESA's ERS-1 satellite, and to the performance level usually credited to the United States Lacrosse radar reconnaissance satellite. Other depictions of Osiris show an X- or S-band synthetic aperture radar radiating 3-5 kW and generating imagery at a ground resolution of 3-5 metres. Thomson has been working since the mid-1980s on travelling wave tubes emitting up to 30 kW for such a mission.

The Zenon electronic intelligence satellite project, more tightly classified than even Osiris or Helios, went as far as a one-year competitive definition study, awarded in mid-1992 to two teams led respectively by Matra, allied with Dassault Electronique, and by Alcatel with Aerospatiale and Thomson. Two small satellites called Cerise and Clementine (no relation to its United States namesake) built by Matra under licence from Surrey Satellite Technology Ltd. will be launched along with Helios IA to map radio emitters around the world, a mission intended to help design sensors and tasking procedures for the future elint satellite. Another 50-kg satellite, called

UPM-LB and built by Universita Politecnico de Madrid, will ride along with a similar mission, suggesting that Spain is already involved in Zenon's definition. Helios IA was reported in 1987 to include an elint payload called Eurecom, of which no more has since been heard.

Finally, defence officials would like to obtain their own missile warning capability in the longer term, to reduce dependency on the United States' goodwill in sharing Defense Support Program warning messages. Both Aerospatiale and Matra publicised early warning satellite concepts during 1993; the two companies, which respectively developed ESA's infrared Space Observatory and infrared radiometers for the Meteosat meteorological satellites, can claim expertise in the relevant areas. Matra has estimated a two-satellite system at Fr5 billion, with another Fr3 billion required to launch a demonstration payload on some other geostationary satellite around 1998. This shopping list was too much, both for the defence ministry's senior level and for the increasingly assertive Parliament; the budget which came out of the latter at the end of 1993 marked a net decrease, with appropriations falling 7 percent to Fr3,606 billion in 1994. France has not cut its defence budget when almost every other major military power in the world sent troops home and cancelled programmes. Though the five year, 1995-2000 defence programme law, which the National Assembly voted in in June with few amendments, offers an average growth rate of only 0.5 percent per year, it is still exempt from the guidelines of another five-year plan, passed last year to reduce government expenditure. The cap set on the budget's annual growth may be lifted to 1.5 percent from 1997-2000, subject to improvement in the country's economy.

Since some sacred cows still had to be sacrificed, a few major new starts were postponed—a new antiship cruise missile, the new M5 submarine-launched ballistic missile, and the newest satellite projects. The launch of Osiris, whose development phase should now start in 1998, slips from 2001 to 2004: Zenon is not even mentioned, but the law hints at the money to be spent to replace existing assets, the Berry surveillance ship and the Sarigue airborne system. Whether reasons other than strictly financial lay behind these decisions is not known; Osiris and Zenon had already been postponed in 1991 due to budget constraints. The Helios and Syracuse programmes are the only ones apparently enjoying the Parliament's full support, and even then the National Assembly inserted an amendment in the defence programme law, specifically directing that the government continue to seek European partners willing to share in the cost of Helios 2; Italy and Spain already contribute 14 percent and 7 percent of Helios I's total cost, respectively. Leotard has assured deputies that Osiris and Zenon would also only be envisaged in the framework of European cooperation. Yet, with development costs of Fr10 billion and Fr11 billion quoted for Helios 2 and Osiris, respectively, the law is still good news to the industry; MMS and Alcatel Espace now derive up to a quarter of their sales from military space.

Defence officials also make no mystery of the challenge which managing Helios will constitute, and of the risk that the General Delegation for Armament (DGA), the ministry's tri-service procurement agency, is overextending itself in getting into the spy satellite business, possibly with insufficient preparation. DGA officials thus estimated in 1992 that its staff working on space systems would have to grow eightfold over the next ten years, from about 100 personnel, noting that "forming image interpreters and the people in charge of data fusion becomes a priority in any military space programme." Faced with this challenge, the Ministry of Defence had to conclude in early 1993 that setting up an entire new space agency was not a realistic proposal, and to resort to a desperate move: transfer part of the management of its space programme to the civilian space agency, CNES, which it had so far carefully confined at an arm's-length, purely technical function. There seems to have been little change in ongoing programmes, since CNES already acted as the Helios "system architect" and prime contractor to DGA since 1987, also managing the development of the satellite control centre its tasking system and a preparatory programme all derived from similar systems put in place for SPOT. About 210 CNES employees are currently involved in Helios, including 60 full-time personnel, along with 1,250 engineers spread among contractors. About 75 percent of the development cost of Helios, or Fr6 billion, was channelled through CNES, under the "internal resources" (ressources propres) line item; DGA money accounted for 10 percent of the CNES budget in 1991.

French military space programmes are administered at the highest level by the Space Studies Group (GES), chaired by a major general in the office of the general chief of staff and by DGA's Director of Missiles and Space. Since 1992, a general attached to the general chief of staff is also in charge of helping the services use space assets. GES receives input from a planning committee, the Military Space Co-ordination Group (GCSM) staffed with more officers from DGA and the services. GCSM is believed to have absorbed a DGA-CNES steering committee formed in 1992, the Delta Committee, and this to include a CNES representative as well. The GCSM, since 1983, prepares a document known as the Multiyear Military Space Plan (PPSM), since 1983, prepares a document known as the Multiyear Military Space Plan (PPSM), updated every other year for the Minister of Defence. Also involved is DGA's other division, the Command and Information Systems Directorate, formed in 1993 by combining the Terrestrial Armaments Directorate and the Electronics and Information Directorate and which runs the Syracuse project.

SPOT Commonality

Helios involves the same contractors as SPOT, except for some foreign suppliers, and will generally operate

along the same lines; government officials are keen to point out that commonality with SPOT saved the Ministry of Defence's Fr1.3 billion. A surveillance satellite project ran alongside CNES' SPOT from the beginning, with studies initiated in 1977 on a concept called SAMRO. This was cancelled in late 1982, officially over budgetary preoccupations but also amid reports that the satellite's camera would not achieve a resolution better than 6 metres, which, if true, would have justified sending the proposal back to optical engineers. Studies resumed in 1985, possibly in connection with the intelligence shortcomings experienced by French troops in Chad and after CNES and the Ministry of Defence, which contributed about 30 percent of SPOT's development cost, had acquired some hands-on experience.

Most details of the project's progress are evidently classified, but there is evidence that commonality with SPOT did not suffice to make it entirely smooth. To begin with, the programme is 2-3 years late from the target launch date of 1992 reported in 1986 by contractors. Part of this delay was attributed in 1990 by defence officials to a fairly serious dispute with their Spanish counterparts, who expressed an intention of claiming their 7-percent share of the satellite's time "over the places we're interested in, in the Middle East." The limited data publicly available on the programme's cost also point to an upward trend, though Matra officials deny that any cost overrun occurred; the Helios system has evolved since 1986 from a constellation of 3-4 satellites and a total development cost of Fr10 billion (about Fr12.2 billion at 1994 price levels, if indexed on GDP), inclusive of launches and ground segment costs; this cost had been reduced by 1990 to Fr6.7 billion, but, the system was limited to two satellites, for which CNES contracted with Matra at the time for a total of Fr3 billion, or about the same cost per satellite as for SPOT 4. The system's total cost now stands at nearly Fr8 billion, a 19.4-percent increase in four years, and maybe doubling in cost per satellite.

The satellites' launch mass also grew, from about 2,000 kg to 2,500 kg. French suppliers had to be found to replace SPOT's few foreign contractors, in particular for Helios' on-board tape recorders developed by Schlumberger Industrie SA and which are said to remain troublesome. The satellite's higher resolution required new assembly procedures and facilities at Aerospatiale's plant in Cannes-La Bocca, where Helios' precision optics were integrated in a class 100 chamber; research was also funded by CNES and DGA to reduce jitter to within hundredths of a microradian, by damping all shocks and vibrations, in particular from the mechanical tape recorders, to a maximum acceleration level of 10 in the power -6 g. This corresponds to the Hubble Space Telescope's stability performance, which doubtlessly owes much to similar research done by Lockheed Missiles & Space Co. and other U.S. manufacturers of surveillance satellites. Finally, secure facilities had to be built to keep Helios in the black, complete with scrambler phones and bug-proof rooms, which has traditionally added much overhead to military satellite programmes. Such sites are know to include Matra's Building M1 in Toulouse, where the spacecraft are integrated in a 1,800 square meters clean room and extensive optical assembly facilities at Aerospatiale in Cannes-La Bocca.

How the arrival of Helios will shake up France's intelligence bureaucracy, often criticized as sleepy and inefficient, will also be interesting to watch. Just as CNES set up SPOT Image S.A. to market its remote sensing satellite, a specific organisation will probably be installed to manage satellite intelligence, similar to the U.S. National Reconnaissance Office. Image processing and interpretation facilities are already centralised at the Defense Experimental Center for Phot-Interpretation (CEPIA) on Air Base 110 at Creil, near Paris. CEPIA will be run by the Military Intelligence Directorate (DRM), a new general staff body formed in 1992 to consolidate various defence intelligence offices. However, as in the United States, some of the services seem eager to retain their own space branches and their own satellite intelligence pipelines. At the same time that DRM was put together, the French Navy was reportedly allowed to open an External Relations Office (BRE), subordinate to the Naval Staff's Naval Operation Center. The reasoning behind BRE's creation was that analyzing fleet movements from satellite and other data is a seaman's job; plans to develop a dedicated ELINT system similar to the U.S. White Cloud programme would not come as a surprise in a country devoting so much of its defence expenditure to aircraft carriers and strategic submarines. The Air Force also set up its own command earlier this year, the Air Command for Surveillance, Information and Communications Systems (CASSIC).

One task of CEPIA will be, every day at 11 a.m., to collect tasking requests from the three data reception and processing centres operated by Italy at Pratica di Mare, near Rome, by Spain in Torrejon near Madrid, and possibly by the verification facilities established by the WEU [Western European Union] at Farnborough in England. By 5.30 p.m., the French centre will in principle have prepared the satellite's schedule for the next day, to be sent to the control centre, housed in a new, five-story building at CNES' Toulouse Space Center, a backup centre is known to be located on Francazal AB, near Toulouse. Imagery will then be acquired, stored on the satellite's tape recorder, and downlinked every night between midnight and 4 a.m. to Earth stations in Colmar in France, Lecce in Italy and Maspalomas in the Canaries. A separate tasking system, restricted to French users, may be in place for an electronic intelligence payload called Eurocom, believed since 1987 to be piggybacked on Helios IA.

The establishment of CEPIA and other parts of Helios' ground segment must constitute a good market in itself.

Dassault Electronique and Fleximage S.A., a small company set up in 1989 and owned 33.4 percent by Aerospatiale since 1993, are CEPIA's principal contractors. Other sensor fusion and image analysis systems which will probably be part of Helios' ground segment include two Thomson-CSF products: the Air-mobile Modular System for Aerial Operations (SAMOA) transportable ground station, and the System for Acquisition, Photo-Interpretation and Remote Sensing (SAPHIR), a geographic information system developed with a second company, Clemessy S.A.; two products of Alcatel ISR, the Intelligence Data Fusion and Exploitation System (FOCAL) and the Delmos workstation, developed for the French Navy; and various mission rehearsal and image processing systems developed by Matra's MS2I subsidiary, such as the Eagle workstation bought in 1993 by the U.S. Air Force to acquire and pre-process SPOT images. Another key ground segment contractor appears to be SESA, which conducted studies for the definition of the Helios control centre and a programme called EPEIRE, described as the master plan for military intelligence through 2000.

Finally, French diplomats and politicians will soon be able to slip Helios photographs in their briefcases; what will they do with them? One benefit of owning a surveillance satellite is the ability to organise spectacular slide shows for foreign heads of state at critical moments. U.S. diplomats have regularly set up such performances, which have reportedly been instrumental in convincing King Fahd of Saudi Arabia to let United States troops into his country to oppose Iraq in 1990; President Mitterrand was said to have been especially vexed when his U.S. Navy briefer refused to leave his pictures behind. Not only will Helios reduce France's dependence on United States goodwill in the future and raise its stature within the WEU, but French intelligence officials may occasionally be able to walk into CIA headquarters with pictures which cloud cover will have prevented U.S. satellites from acquiring.

Such exchanges may not yet be completely on a par, however. For one, the lone Helios IA will have a fairly long revisit time of 48 hours. Perhaps more significantly, the resolution of Helios IA, widely held to be about one metre, falls well short of that of the CIA's own assets, reputed to achieve an order of magnitude better accuracy. A parliamentary report noted last year that technical limitations of the Helios I programme include the imaging optics, and recommended that the Helios 2 series offer higher visible resolution and an infrared payload. The defence ministry statement announcing the approval of Helios 2's definition phase indicated compliance with these recommendations, mentioning increased collection capacity and resolution. Upgrades of Gould and GEC-Marconi infrared cameras demonstrated in 1990 on a Mirage 2000 test aircraft were already reported at the time to be under consideration for Helios 2.

In the meantime, Helios I will not even be alone in offering 1 metre resolution, since similar imagery will be available from about 1996 from commercial satellites such as Eyeglass and Lockheed's Commercial Remote Sensing System, which the U.S. administration recently licensed. No-one could have expected that in 1986, but French policy seems to continue to consider five metres as the highest acceptable resolution for a civilian system, and even that performance will not be achieved by the SPOT system before SPOT 5 is launched around 1999. There may be some irony in this, given the alarm which SPOT's 10 metre resolution generated within the U.S. government in the 1980s; a 1986 CIA document, obtained under the Freedom of Information Act, noted that "our analysis of the (SPOT) optics suggests that the resolution may be as good as 8 metres. In either case, we suspect that the imagery—which will be commercially available—will have military intelligence value." The French government itself was ambivalent toward SPOT, setting up a SPOT Restricted Interdepartmental Group (GIRSPOT) in 1986 to examine image sales, and veto some of them if need be.

Spain Withdraws From HELIOS-2 Program

BR0311124894 Paris AIR & COSMOS/AVIATION INTERNATIONAL in French 30 Sep 94 p 31

[Christian Lardier report: "Spain Abandons HELIOS-2—Spanish Government Gives Up Its Participation in the French Military Observation Satellite Program HELIOS-2"]

[FBIS Translated Text] The HELIOS-2 program adopted by France in April 1994 aims to launch a second-generation observation satellite in 2001. After Italy's withdrawal, Spain was the only foreign partner to participate, to the tune of 7 to 13 percent, in this project estimated at 8 billion French francs [Fr]. In return, the Spanish firms Casa, Crisa and Sener for the satellite as well as Crisa and Inisel for the ground segment could continue cooperating with MMS (Matra Marconi Space) on the successor to HELIOS-1.

The HELIOS-1 program is being carried out jointly by France (79 percent), Italy (14 percent) and Spain (7 percent). The platform originating from the MMS SPOT-4 carries a high-resolution (about one meter) Aerospatiale camera. The first Helios 1-A is due to be launched in March 1995 by an Ariane-4 rocket while the HELIOS-1B will be ready for launching at the end of 1995. However, the contract with Arianespace has not yet been signed for the second satellite. These 2.5-tonne spacecraft are built by MMS (the contracting authority), Aerospatiale, Alcatel-Espace and SEP [European Propulsion Company] in France, Alenia Spazio in Italy, and the three above-mentioned Spanish firms.

The second generation satellite will be derived from the SPOT-5 and will carry a camera with resolution which could reach 50 centimeters. It will have an infrared channel to improve night vision. The ground segment will comprise receiving stations in Colmar (France),

Lecce (Italy) and Maspalomas (Spain) as well as management centers in Creil (France), Rome (Italy) and Madrid (Spain). Creil will be the only center to have the controlling system. As for the satellite, it will be controlled by a special center in Toulouse. Spain's withdrawal can only come as a surprise in the context of such a strategic program for Europe.

MICROELECTRONICS

Germany: Optoelectronic Chip Passes Integration Test

BR2810152694 Bristol PHYSICS WORLD in English Oct 94 p 27

[Article by George Guekos: "Optoelectronic Chip Passes Integration Test"]

[FBIS Transcribed Excerpt] Designing a chip that can perform both optical and electronic operations is one of the outstanding challenges in optoelectronics. A chip that enables the complete bandwidth of optical fibre to be used in coherent optical communication is another key goal. Therefore the development of the world's first single-chip optoelectronic heterodyne receiver represents a major advance towards both goals. This breakthrough was reported by Helmut Heidrich and colleagues at the Heinrich-Hertz Institute in Berlin, at the 20th European Conference on Optical Communications in Florence last month. [passage omitted on background work in optical communications]

The Heinrich-Hertz chip combines 14 devices in a single component measuring 1.5 x 12 mm, and represents the key building block for a complete optoelectronic receiver circuit. Although this is small compared with the number of devices on an electronic integrated circuit, the complexity of the different functions performed by the chip—polarization matching, heterodyning, photodetection and electronic amplification—represents an impressive achievement.

The receiver currently has two optical inputs—one for the fibre (the signal) and one for the local oscillator. Although the light is linearly polarized when the signal is sent, it changes gradually along the fibre and, when detected, it has a randomly varying elliptical polarization. However, for efficient mixing and detection, the signal and the local oscillator polarizations have to be matched. The Heinrich-Hertz chip uses four polarization splitters to separate the transverse electric (TE) and the transverse magnetic (TM) polarization components of the signal and the local oscillator. Both TE components are sent to one 3 dB (50:50) coupler where they are mixed, and both TM components go to a second coupler.

The outputs from each coupler are then sent to two twin-balanced photodiodes (four diodes in all), which produce electrical signals that are added and amplified by two resistor/junction field-effect transistor combinations to provide two electrical outputs. An external electronic circuit can then process and extract the exact duplicate of the signal sent by the remote transmitter.

The latest versions of the receiver now include a built-in tunable laser (the local oscillator) and thus only need one optical input, making the chip easier to package and cheaper to fabricate. The local oscillator operates between 1547 and 1551 nm (R Kaiser et al. 14th IEEE International Semiconductor Laser Conference in Maui, Hawaii, 19-23 September 1994). Tunability of the laser wavelength, stability in amplitude, frequency and phase, and a narrow emission linewidth will all be important requirements in such a device.

The Heinrich-Hertz chip amply demonstrates that full optoelectronic integration is long and difficult, but that the rewards can be great. The group's receiver required several well-controlled epitaxial growths, an impressive number of lithographic steps and some 150 processing steps. However, the chip is still quite large and only a few can be obtained from a standard two-inch indium-phosphide wafer. Nevertheless, by combining a variety of tricky optical tasks—such as polarization matching and heterodyning—with electronic amplification on a single chip, the Heinrich-Hertz researchers have made a significant advance on the road towards useful optoelectronic integration and coherent communication.

Netherlands: Philips To Launch 80C51-Compatible Computers

BR0411081794 Paris ELECTRONIQUE INTERNATIONAL HEBDO in French 29 Sep 94 p 26

[Report signed 'E.F.': "Philips Enters the 16-Bit Microcontrollers Arena"]

[FBIS Translated Text] With 80C51 architecture extended to 16 bits, Philips's family of 80C51XA microcontrollers performs at least four to 10 times better than its predecessor.

Now 80C51 architecture is expanding once again. Philips will test at the beginning of 1995, at the same time as Intel, the first version of a new family of microcontrollers compatible with 80C51 architecture. The Philips family, called 80C51XA for eXtended Architecture, is based on 80C51 architecture extended to 16 bits for the internal databus. This architecture will be in direct competition with Intel's MCS251. The Dutch firm developed the architecture on its own after breaking its agreement with Intel. Announced a year ago, it was designed to fill the gap between the classic 80C51 and the more expensive 16-bit solutions. It is destined for either 80C51 users seeking to improve their applications performances or users hesitating to move on to 16 bits for cost-related reasons. According to Thomas S. Brenner, head of marketing in Europe for Philips, the 80C51XA family has a better performance/price ratio than Hitachi's HC16 family of 16 bits or Intel's 80C196. The first microcontroller of the 80C51XA family will cost under five dollars for 200,000 units. Production should start during the summer of 1995.

At an identical clock frequency, the 16-bit microcontroller nucleus of the 80C51XA performs four to five times better than the 80C51 because instruction processing only requires three clock cycles instead of 12. The use of all the characteristics of XA architecture, notably the use of high-level programming languages, will improve its performance levels even more.

As Many 80C51XA By-Products As 80C51

Further, 16-bit operations are carried out two to three times faster than with an 80C196. Like Intel's MCS251, the 24-bit address bus extends the address memory space to 16 Mo, against the 80C51's 64 Ko. Compatibility at the level of the assembly code is guaranteed as each 80C51 instruction corresponds to an instruction on the 80C51XA (translation is automatic). Additional instructions enable the characteristics of the XA nucleus to be used. The latter is characterized by its low consumption due to static operation, and low noise level due to optimization at all levels. Further, it is optimized for multijob operation.

The initial version of the 80C51XA family as well as the 32 kilobytes of EPROM [erasable programmable read-only memory] or ROM [read-only memory] memory, 512 RAM [random access memory] octets, three time switches, a watchdog, two UART's [Universal Asynchronous Receiver Transmitters] and four 8-bit input/output ports (or two 16-bit ports). It will operate at 20 megahertz [MHz] under 3 volts [V] or at 30 MHz under 5 V, and 50 MHz versions are also planned. The external address buses are programmable on eight, 12, 16, 20 or 24 bits.

80C51 architecture currently represents 28 percent of all sales in 8-bit microcontrollers in the world. Philips holds nearly 30 percent of the market of 80C51 in the number of units delivered and half of its sales are in Europe (According to Dataquest, Philips sold 57 million 80C51's and Intel only 43 million in 1993.) Like the 80C51 family, Philips offers a number of by-products, notably with counters and time switches, programmable counters, several input/output configurations and several EPROM, ROM, EEPROM [electronically erasable programmable read-only memory] and RAM memory combinations. The software and material tools and development systems (compilers, assemblers, emulators, etc.) are also under preparation.

TELECOMMUNICATIONS

France: ATM Experimentation at French National Research Institute

BR2810152794 Rocquencourt ERCIM NEWS in English Oct 94 p 11

[Article by Olivier Muron; "ATM Experimentation at INRIA"]

[FBIS Transcribed Text] France Telecom is providing INRIA [National Institute for Research on Information Science and Automation] with a virtual private network offering 25 Mb/s [megabits/second] interconnection between sites at Rocquencourt in the Yvelines (west of Paris), Sophia Antipolis (on the French Riviera) and Grenoble in eastern France.

INRIA signed an agreement with France Telecom to carry out an experiment on ATM [asymchronous transfer mode], starting in September 1994. INRIA will have real time access to information on this private virtual network from a network administration terminal, and will be able to process information on traffic statistics and parametrizable events. The service will be multiprotocol; INRIA will use the Internet IP protocol with connections via Ethernet, Token Ring or FDDI LAN interfaces. The service is supported by a network of ATM concentrators using the Connectionless Broadband Data Service (CBDS) protocol.

INRIA plans to use this network to experiment with the following applications:

Interactive Cooperative Work

Teleseminars and teleconferences using INRIA-developed TELESIA-IVS software will involve various research centres. Tele-information sharing experiments will be carried out using the above-mentioned technologies together with such dedicated tools as 3 "Live Boards" provided by Rank Xerox (one per test centre).

Although TELESIA-IVS-driven teleseminars and teleconferences have almost moved beyond their purely experimental phase, these tools have not always been used on a regular basis with sound and image on the Internet. Due to problems resulting from asynchrony and load variation, performance has necessarily been limited. The scheduled experiments will therefore demonstrate whether TransREL-ATM type services can broaden the range of uses and make TELESIA-IVS a regular work tool not only for teleconferences but also for user-friendly, mainstream telemeetings. Tests will also be carried out on network flow control and on the scientific potential for a research project on RODEO high-speed networks at INRIA-Sophia Antipolis.

Multimedia Information Server

A presentation of INRIA and its research activities has been installed on an information server at Sophia Antipolis. This presentation is supported by World Wide Web (http: www.inria.fr:8003) and is accessible via the ATM network from sites in Rocquencourt and Grenoble, allowing rapid consultation of video sequences stored on the server.

High-Performance Digital Simulation on a Remote Server

CM 200 (Sophia Antipolis) and SP1 (Grenoble supercomputers) will be connected to the experimental ATM

network, allowing them to be used for calculations from a remote work station. One specific application of this computing potential involves the development of a new generation of codes for the large-scale analysis of human genome sequences, and the INRIA Rocquencourt genome project will carry out an experiment in distributed computation using the KSR and SP1 parallel supercomputers in Rocquencourt and Grenoble respectively.

These experiments will be measured and analysed both for the data flows generated and for the way the TransRel-ATM service responds to network loads.

France: Report on Information Highway Expected 15 November

BR0311100494 Paris INFOTECTURE in English 18 Oct 94 p 3

[Unattributed article: "Who Will Pay for French Infobahns?"]

[FBIS Transcribed Text] The Thery report on information highways in France should be published by November 15. The report was handed to the Prime Minister on September 15 but its contents have not been generally disclosed. The leaks suggest that the report suggests that France Telecom should be the principal operator of a future information network based upon optical fibre. The current French cable network would not appear to have the bandwidth necessary for multimedia applications unless it undergoes significant technical development necessitating massive investment. The French cable networks have been doing very poorly so far, achieving extremely low rates of penetration in spite of tax breaks and anti-satellite-dish measures by the minister implicated in the recent corruption scandal.

The authors of the report feel that cable is neither a base to build on nor an obstacle, although in the long term the two kinds of network will coincide. Only half the current networks will still be in place in 15 years' time, notably those who have invested in information networks.

The association of French cable operators recently declared that they can only become competetive if they are allowed to offer telephony services.

Prospects of European Information Highways Assessed

MI3110141694 Leinfelden-Echterdingen COMPUTER ZEITUNG in German 15 Sep 94 p 14

[Article by Gerd Tenzer: "Even the EU Attaches Great Importance to the European Information Highways—Information Highways Are also Enormously Important for Germany"]

[FBIS Translated Text] Information highways are becoming increasingly important all over the world. In Europe, too, an increasingly high value is being placed on information highways. Information highways must not and should not stop even at the borders of the eastern European countries—their importance for the recovery of these nations is enormous.

Even before the American president, Bill Clinton, put "information highways" on top of the agenda, everyone was talking about information superhighways, or data highways as they are called in German. President Clinton has even made the creation of these highways a cornerstone of his technology policy under the title, "National Information Infrastructure." The EU [European Union] Commission gave the European information superhighways high priority in its "White Book" on "Growth, Competitiveness, Employment—Challenges of the Present and Paths to the Twenty-First Century." Forty billion ECUs are to be invested in this sector alone by 1999, another ECU15 billion in ISDN [Integrated Services Digital Network] networking, a further ECU10 billion in videocommunications and interactive video, ECU7 billion each in data exchange between authorities and telemedicine, and ECU3 billion each in teleworking and distance learning. The "White Book" also proposes investing a total of about 300 billion German marks [DM] in information and communications technologies within the next 10 years. Even if only part of these sums are invested throughout Europe, the proposals show the importance now being attached to information highways at the European level.

Turnover More Than Two Billion with ISDN

Telekom has opened up the Euro-ISDN together with 25 network operators in 20 European countries. It will lead to a large market for terminals all over Europe, which in turn will lead to falling terminal prices and hence new subscribers. In the meantime, more than one million ISDN channels have been marketed. While in 1991, the revenue from ISDN was DM275 million, the figure was DM1.1 billion in 1992, and the DM2 billion limit was exceeded by the end of 1993. Euro-ISDN means "only" 64,000 characters per second during transmission. That is already very much faster than conventional transmission routes, but still well below the transmission speeds of broadband networks.

The measures initiated by the EU Commission for implementing trans-European networks will also be supported in broadband communications: together with France Telecom, BT [British Telecom], STET [Turin Telephone Finance Company] and Telefonica, Telekom intends to push forward the "Global European Network" (GEN) which will be replaced by a "Managed European Transmission Network" in 1995. Together with 17 network operators in 15 European countries, Telekom is working intensively on testing the asynchronous transfer mode (ATM) which is regarded worldwide as the basis of future broadband switching systems.

ATM network nodes linked by transmission technology with at least 34 megabits per second—possibly even 155 megabits per second—are being set up in the countries

taking part in the ATM pilot trial. From the middle of this year, the test network will be available for the first trials. Applications between local networks, between metropolitan area networks, and multimedia applications will be tested. The keywords here are high-speed data and transmission of moving images. In contrast to narrow band ISDN, these broadband applications require glass fibers as far as the customer. Both technologies, both "fiber in the loop" and ATM switching, form the backbone for the supply of broadband multimedia services in addition to the high bit-rate transmission link over long distances.

Apart from the standard use of glass fibers in the long distance and local call network —about 1.4 million kilometers of fibers will be incorporated in the long distance call network by the end of 1994—private and business subscriber lines upgraded with glass fiber lines were brought into operation in October of last year.

By 1996, 1.2 million households in the new German laender will receive a standard glass fiber line; 500,000 glass fiber lines are planned for this year. To this end, about 200,000 kilometers of fibers must be laid, requiring an investment of about DM1.2 billion.

The Trans-Europe Line, or TEL for short, is the first digital glass fiber cable network to eastern and southern Europe. TEL is also an information highway of great importance because of the contribution it will make to breaking down the existing boundaries in telecommunications links between eastern and western Europe.

In January of this year the go-ahead was given for the link to Warsaw, Prague, Bratislava, and Budapest, and the link to Croatia, Slovenia, and Austria. This is only the first 3,700 kilometers of this project.

As 14 telecommunications organizations are now taking part in the TEL project, the project was extended to 14,000 kilometers. Romania, Ukraine, Belarus, Lithuania, Moldavia, and Bulgaria are also taking part now. Negotiations are still underway with Russia. The investment is about DM700 million.

An Information Highway Must Overcome Borders

Information highways should not and must not stop at the borders to the former eastern bloc because the economic recovery of the countries in eastern and central Europe is of enormous importance for the states of western Europe and, of course, for Germany, too.

The basis for the projects mentioned above is a well-developed and modern telecommunications network tailored to customers' needs. The objective is a fully digital, broadband, variable transport network based on glass fiber and ATM technology, in which all kinds of telecommunications services can be integrated irrespective of their bandwidth.

Rapid digitalization of the network and the use of glass fiber technology are crucial for the successful implementation of these projects. Digitalization is the key for many new telecommunications services that cannot be implemented with analog technology. Only by using digital technology throughout is it possible to offer flexible, customer segment-specific tariff and billing systems, provide proof of individual calls and issue individual customer invoices, achieve new, modern performance features in an efficient manner, provide quicker installation times leading to higher quality, and make substantial improvements in the ability to make process and product innovations.

The network strategy of Telekom therefore includes three key points: Firstly, the rapid continuation of switching technology digitalization and further development of the system to form an "intelligent network" which makes it possible to provide new services and performance features in an ISDN network. Secondly, continuation of transmission technology digitalization and the introduction of "synchronous digital transmission technology" incorporating modern network management. As a result, a considerable cost saving potential can be utilized to increase the efficiency of the transmission network and reduce the future investment requirement even further. And thirdly, the early use of glass fibers in terminals. Over the next few years, therefore, Telekom intends to replace copper cables by glass fiber technology in the local network, too.

The new network components are also opening up opportunities for organizing the network in the local and line circuit areas. There are no longer any technical limits. Large switching units can be set up as "intelligent parent exchanges" at almost any location. Only the efficiency of transmission-related solutions determines the limits to the management domains of such exchanges. On the basis of new technical possibilities, it should also be possible to reduce the existing 9,000 or so line circuit areas to an order of magnitude of about 500 management domains.

ATM on Trial in Europe since Mid-1994

The supply of ATM services is one of the prerequisites for implementing an information highway in Europe. Pilot projects have been running in all the major western European countries since the middle of this year.

Europe: A joint ATM pilot project is currently being prepared by a number of European network operators. British Telecom, the German Deutsche Bundespost Telekom, France Telecom, the Spanish Telefonica, and the Italian STET have submitted a memorandum of understanding which has now been signed by 18 network operators in 15 countries. The starting gun for the first test network will be fired some time this year.

Germany: The first test run is underway in Berlin, but the Hamburg and Cologne nodes have not yet been brought into operation, contrary to Telekom's announcements. Next year, Deutsche Bundespost Telekom and France Telecom want to provide a cross-border service based on ATM-supported broadband

ISDN. A test run between Stuttgart, Freiburg, Karlsruhe, and Ulm on the German side, and Paris and Lyons in France will take place this year.

Finland: The first commercial ATM service in the world was tested in March 1993. There are now services available in Helsinki and Tampere.

France: France Telecom is taking part in the European pilot projects. A virtual ATM cross-connection is planned for 1995. It will join together networks previously operating at speeds of 34 megabits per second on the basis of synchronous digital hierarchy (SDH). At present, the French are still considering whether line-oriented services should be offered.

Great Britain: British Telecom is taking part in the European ATM projects and is itself also planning to introduce ATM. As yet, however, there is no fixed date for starting the corresponding services. Mercury also began test runs this year, but has not yet submitted any concrete timetables.

Italy: STET is involved in the European pilot project. ATM cross-connections to link the metropolitan area networks in Turin, Florence, and Venice are planned by 1996.

Netherlands: A pilot project is in progress in nine locations within the academic Surfnet. There are no plans to offer services.

Growth of European Market for Information Technology Reported

95WS0026D Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 21 Oct 94 p 8

[Article: "Growing Market for Information Technologies"; subhead: "Best Opportunities for Work Stations, Local Area Network Systems, Personal Computers"]

[FBIS Translated Text] Frankfurt—In the current year, European markets for information and communications technology will grow by 6.5 percent to ECU276 billion (approximately 533 billion German marks [DM]). The European Information Technology Observatory (EITO) (c/o Eurobit, Lyoner Str. 18, 60528 Frankfurt, Fax: 069-6603-510) reports that a growth rate of more than seven percent is anticipated for 1995.

Telecommunications services constitute the largest market share with 43 percent, followed by software and information technology services with a combined 27 percent, computer hardware with 15 percent, communications technology hardware with 11 percent, office technology with three percent and data communications gear with one percent.

EITO is predicting that work stations, local area networks (LAN) and personal computers will be far above-average and even occasionally have double digit growth rates in the current and upcoming year. Also, reportedly, a two-percent softening of the market for hardware services may be expected whereas for other services a growth of six to seven percent and for software even of eight percent is on the horizon. Information technology hardware turnover will increase by a good three percent.

In the future, the impetus for growth will also originate with the market for software. For 1994 a rise in market in volume of 7.5 percent can be expected and for 1995, 9.0 percent. The driving forces in this context are Windows, network supported systems, applications software and so-called distributed computing. The telecommunications market is likely to remain stable. In 1994 and 1995, growth there is likely to remain above eight percent. In Europe, Germany is the largest national market with 25 percent.

Broadband Services Tested on Eastern German Optical Networks

BR0411094994 Swanley NETWORK EUROPE in English Sep 94 pp 46-47

[Unattributed article: "The Light Turns Out the Switch"]

[FBIS Transcribed Text] It is now commonplace, indeed it is a cliche, to say that telecommunications is undergoing dramatic upheaval.

Yet, however dramatic the changes of the last two decades, the upheavals of today are only just the beginning. When optical technology displaces electronic switching, as it has displaced electrical transmission, then the upheavals will start all over again.

If present research trends in fibre optic switching and transmission technologies, collectively known as "photonics," can make the transition out of the laboratory and into operational networks, and prove their economic feasibility, then the whole debate about, say, ATM [Asynchronous Transfer Mode] will appear to have been wholly academic.

A clue as to just how dramatic the changes might be comes from a RACE II project, known as Mundi. RACE stands for Research in Advanced Communications in Europe and is the European Union's existing telecommunications research and development funding programme. Mundi stands for multiplexed Network for Distributive and Interactive Services.

The project teams, Deutsche Telekom and Siemens from Germany, Corning Europe from France, Philips Research Laboratories from the Netherlands, and BT [British Telecom] and GEC-Marconi from Britain, will, starting this October in Dresden, demonstrate the use of "High Density Wavelength Division Multiplexing," HDWDM, over local loop "passive optical networks."

Passive Optical Networks, PONs, are currently being deployed, albeit on a fairly limited scale, to provide fibre service to the home or to the kerb. PTOs are careful

about investing heavily in fibre optic local networks because they may simply replace their existing assets in copper networks without raising revenues substantially.

Deutsche Telekom is treating the need to urgently upgrade east Germany's network as a "greenfield" opportunity to install large amounts of fibre-to-the-home. At the moment PONs work in the narrowband range providing limited transmission speeds, and requiring different telecommunications and television networks. If new technologies could be found to make use of narrowband PONs to provide broadband services then the economics of their deployment could change dramatically.

The Mundi project aims to develop a variety of ways of upgrading narrowband PONs to high capacity, unlimited bandwidth networks using HDWDM techniques. The project will show two different high bandwidth services. The first, provided by Siemens, is a one-way distribution of television images designed to exploit a hybrid fibre-optics and co-axial distribution network. The second, provided by British Telecom, is an interactive multimedia service over all-fibre networks.

Both high bandwidth services will run alongside Deutsche Telekom's narrowband telephone service on the same PON. In technical terms this is achieved by using the 1300 nanometer "window" for narrowband telephony and sharing the 1550 nm window for broadband. Theoretically the 1550 nm window provides for effectively unlimited bandwidth, though initially in the trials 155 Mpbs will be used.

According to Professor Peter Cochrane, head of advanced applications and technology at BT's research centre near Ipswich, the project will revolutionise telecommunications in two ways.

First, it ends the problem of bandwidth limitation which has effectively determined the structure and economics of telecommunications—local networks joined into backbone networks. "The new solution to bandwidth on demand is to throw bandwidth at it," says Cochrane. "Time division multiplexing and compression are good ways of using limited bandwidth; the other solution is to make bandwidth unlimited."

This offers considerable advantages over the technology used in ATM, for example. Cell relay techniques, such as ATM, break transmissions down into packets, send them over a network, and then reconstitute all the pieces. This necessarily involves delay while the computers break up, wait to send, wait to receive and put back together in the correct order. All this is done to get the most out of limited bandwidth.

As Cochrane points out, "So far there have been no large scale trials or modelling" or complex ATM type networks. "Consequently we do not adequately understand what the service implications will be."

However, the HDWDM technique provides each call with two channels that remain open and exclusive for the duration of a call. The need for "packetising," and its role as potential bottleneck, is avoided. This does not mean that ATM will be incompatible; it will still run "on top" of the underlying HDWDM network, for example.

HDWDM can be regarded as providing analogue transmission in the sense that it is possible to exploit transparency between terminals, there being no signal-specific regeneration en route. Combined with optical switching, effectively another analogue technique, we are seeing a double reversal of the role of analogue and digital communications technologies.

The second mayor consequence of HDWDM is that it could utterly transform our understanding of telecommunications switching. Cochrane says HDWDM will remove the need for telephone switches, or "exchanges," in towns. The equipment needed to set up a connection between two users could instead be distributed out to the peripheries of the network, attached to the user's office or living room wall. The network will still need to provide computer functions but that intelligence can, of course, be located anywhere.

"We will see migration to telecommunications switching systems the size of a shoe-box that fits on your garage wall," says Cochrane.

As HDWDM technology is refined and the number of wavelengths that can be multiplexed is increased, Cochrane forecasts that switches will no longer be needed in cities or small nations. The technology will carry millions of calls at once, with users effectively "tuning" into the wavelength, rather like radio listeners tuning into a wavelength for a particular programme.

The existing structure with PTOs providing switching and transmission capacity and services would, thus, be totally transformed. BT's invention might undermine its own, and its counterparts', existing purpose in life.

The need to keep close to a 2-kilometre limit on local loop links, has led to hierarchical networks which are "thin" in the local reaches, but incredibly "thick" at the trunk and the international levels.

"If we exploit the inherent reach capability of optical fibre and extend the local loop to greater than 40 kilometres, we then see complete national networks of less than 100 switches possible," says Cochrane. "Suddenly the network has become purely a local loop: no core network, no international level, just the local loop."

The consequences of this for PTOs such as BT and Deutsche Telekom are profound. Cochrane estimates that about "30,000 employees would optimally service the size of customer base that most European telcos enjoy today."

What is more, the way HDWDM would structure telecommunications would seem to be a step in the "internet"-type direction, with free time and capacity use but

with a predetermined subscription fee. This thus raises questions about the function of a PTO. If switching is just another function taken out of the network to the customer's premises, and if bandwidth is unlimited, the PTO would be in the business of supplying a commodity—and there's no profitability in that. Information and content will be the new value-added markets.

And all of this could happen pretty soon. The HDWDM works on its own on a trial set up, and once the integration teething troubles have been ironed out at the Dresden trial site, work on developing the equipment for operational deployment will draw nearer. RACE II ends at the end of this year, but ECU104 million have already been earmarked for research in photonic technology in the RACE replacement, ACTS (Advanced Communications Technology and Services). Mundi project participants say that while "this is one solution in optical switching, not the only one," customers could be using the technology from the start of the new century, and by 2020, given adverse regulatory conditions, or even 2010, given a favorable regulatory climate, such networks could be widely deployed. Telecommunications will transport information across the "optical ether."

Cochrane is aware of the problem his invention creates for his employer. "We are not sitting around waiting but seeking to define our role," he says. Having contributed to the continuing upheavals in telecommunications the Mundi project participants must now prepare for the consequences.

Germany: ATM Pilot Networks at Mathematics and Data Processing Association

BR0211135994 Rocquencourt ERCIM NEWS in English Oct 94 p 14

[Article by Peter Wunderling and Lothar Klein: "The ATM Pilot Networks at GMD"]

[FBIS Translated Text] GMD [Society for Mathematics and Data Processing] started at the end of 1993 to establish ATM [Asynchronous Transfer Mode] based networks at its locations in Schlob Birlinghoven, Darmstadt, and Berlin to provide a testbed for next-generation computer applications with need of high bandwidth and as a backbone for the existing LANs [local area networks].

The driving force behind the ATM activities of GMD is the rapidly increasing need of high bandwidth for computer applications with voice and video and for visualisation in general. Increasingly, the various R&D projects of GMD (e.g., MAT-Multimedia Applications in Tele-Cooperation) require bandwidth which cannot be provided by the existing LANs (e.g., Ethernet). Therefore, GMD decided to establish ATM-based networks at its locations in Schlob Birlinghoven/Sankt Augustin, Darmstadt, and Berlin to provide bandwidth today of up to 155 MBit/sec. The ATM networks are being used as a platform for testing new applications (especially multimedia) and as a backbone for the existing LANs.

In a first step in February 1994, two ATM switches (ASX-100, Fore Systems) were installed at Schlob Birlinghoven and in Sankt Augustin. Both systems are connected via a fiber link (140 MBit/sec) leased from DBP [Deutsche Bundespost—German Post Office] Telekom. Soon after this ATM pilot network became operational, the MAT project could successfully show the first video applications running on top of ATM. In the GMD Laboratory for Parallel Computing, the first throughput measurements with a Sun cluster show a much better performance for the four Suns connected via ATM than via FDDI [Fiber-Distributed Data Interface]. The existing Ethernet infrastructure at both locations now has a backup solution in the 140 MBit/sec ATM link.

At GMD in Darmstadt a similar ATM network with two ASX-100 switches is in use. In Berlin at GMD FOKUS, an additional ASX-100 system has been integrated into ATM networks which already were operational within projects such as BERKOM and BALI (Berlin ATM LAN Interconnection Initiative).

In the next step in September 1994, two Hicom ATM-P switches (Siemens AG) will connect the ATM networks at GMD in Birlinghoven and Berlin with the "B-ISDN [Integrated Services Digital Network] Pilot Network" of DBP Telekom. This broadband pilot network which has access points in Cologne/Bonn, Hamburg, and Berlin, offers ATM links with speeds of 2, 34.5, and 155 Mbit/sec. The B-ISDN Pilot also allows GMD to participate in European ATM activities.

The ATM network in Darmstadt will be connected with the networks in Sankt Augustin and Berlin when the DFN association (German Research Network) offers its 34.5 MBit/sec academic network WiN (based on ATM technology and planned for 1995). Furthermore, it is planned to expand the ATM networks at all GMD locations and to make services available such as video-on-demand and video conferencing.

Ireland: Solitrons Improve Glass Fiber Throughput

95WS0026B Frankfurt/Main FRANKFURTER ZEITUNG/BLICK DURCH DIE WIRTSCHAFT in German 20 Oct 94 p 8

[Article: "Solitrons Improve Glass Fiber Throughput"; subhead: "Such Technology Still Needs Intermediate Amplifier Modules"]

[FBIS Translated Text] Munich—By now glass fiber has thoroughly permeated long-distance telecommunications traffic. By now, worldwide, nearly 40 million kilometers have been laid. Without exception, the circuits exist in the standard single-mode technology. Future development is aiming at two basic goals in this area.

First, an endeavor is being made to span the longest possible stretches without intermediate amplifiers, eliminating the expensive addition of supply voltage. That is especially critical for underwater cables. In this context, the specialized British firm STC Submarine Systems holds the world record with the 270-kilometer-long Celtic cable between Wexford (Ireland) and Land's End on the southwest coast of England.

It operates at a rate of 2.5 gigabits per second. The cable makes nearly 30,000 telephone voice circuits available. By 1995 the same firm will lay a cable without amplifiers between the Spanish mainland and Mallorca and Menorca and then probably achieve a new record with 309 kilometers. In that case, however, voice capability will decline because of wiring with only 622 megabits in 15,000 channels.

The other thrust aims at extremely high capacities. Those utilize the 20-gigabit range Solitron technology. Such a system is capable of being operated on all currently laid glass fiber cables, meaning that no technological retooling is required here.

In the 20-gigahertz technology the signals are transmitted in parallel on several frequencies via the cable. Because of the different wave lengths of the utilized frequencies the signals transit the cable, albeit with varying speed. In the process, glitches and data losses may arise.

One remedy is use of the solitron. That is a sort of light pulse that minimizes dispersion (pulse scattering) with all pulses, despite varying wave lengths, apparently having the same travel velocity through the fiber. But that does not occur without intermediate amplifiers that are still lavish, complicated and costly.

The Philips firm has developed new modules having a 400-fold amplification for the 1,300-nanometer range involved here. According to Philips, the modules are compact and relatively inexpensive to produce. As reported by M. H. Vincken of Philips Research, there is the prospect, using such a solitron system, of making further headway in the direction of even high bit rates and greater intervals between amplifiers.

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